SECOND ANNUAL REPORT

OF THE

NEW YORK

State Commissioner

TO THE

PARIS EXPOSITION OF 1867.

Printed by order of the Senate.

ALBANY:
PRINTING HOUSE OF CHARLES VAN BENTHUYSEN & SONS.
1868.

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COMMUNICATION.

STATE OF NEW YORK:
EXECUTIVE DEPARTMENT,
ALBANY, *February* 26, 1868.

To the Senate:

I have the honor to transmit an interesting report from Colonel CHARLES B. NORTON, a Commissioner from this State to the Paris Exposition of 1867. The report presents a statement of the part taken by our citizens, which is creditable alike to their enterprise, their labor and their genius.

The report is accompanied with diagrams, which will be found especially valuable to those who desire a more definite understanding of the exhibition grounds and buildings, and the position assigned to each country represented.

I cannot forbear commending Colonel NORTON to the favorable consideration of the Legislature for his fidelity to the interests of American enterprise, and his constant regard for the comfort of our citizens who attended the exhibition.

R. E. FENTON.

SECOND ANNUAL REPORT

OF THE

COMMISSIONER TO THE PARIS EXPOSITION

OF 1867.

Bureau of New York State Commission,
16 Rue Auber, Paris.

To His Excellency THE GOVERNOR
of the State of New York:

Sir—I have the honor to present my Second Annual Report as Commissioner from the State of New York to the Paris Universal Exhibition.

In the report made January 1st, 1867, I presented to your notice certain suggestions relative to the Exhibition and its relations to our State, and the best and most proper manner in which to take advantage of the opportunity offered. I had proposed, with the consent of the Legislature, and with sufficient means with which to operate, to have had special arrangements made for the benefit of citizens of New York.

As it was, without such aid, no effort has been spared on my part to so arrange matters that all visitors from that State should be advised as to their best interests in connection either with their visit for business or pleasure, as the case might be.

My Bureau as Commissioner has always been open to New Yorkers for information, and as far as the limited means in my power would admit, I have arranged for their convenience and comfort.

In my preliminary report I referred to the advantages to our State and country of a visit from the Seventh Regiment, National Guard, and also had the honor of corresponding with yourself upon the same subject. I shall always have reason to deplore that this projected visit was not carried out. On its intimation here to the proper authorities, the most cordial welcome was extended, and every possible arrangement commenced to secure the most comfort and enjoyment to the members of the regiment. We should have had no reason to regret the comparison between our own National Guard and the volunteer troops of either France or England. I trust that during the coming year the project may again be brought forward. In this connection I have to express my obligation to General DIX, our Minister to France, for the kind and cordial manner in which he aided my efforts in connection with the visit of the Seventh Regiment.

As a most voluminous and general report is in preparation upon the Paris Exposition, by the United States Commission, formed of scientific and learned men from our country, it will not be necessary for any special reference to the Exhibition as a whole; yet as a State Commissioner, and representing a large number of exhibitors, I feel it my duty to bear witness to the universal dissatisfaction, both of exhibitors and State representatives, with the general management of the American department.

There certainly was a lack of the usual energy and shrewdness of our people in the arrangement of the material presented, and the successful results to which we arrived are due more to personal efforts on the part of State agents and exhibitors than to any enterprise on the part of the agent of the government.

Experience in this instance, has been very valuable, and in any future World's Fair in which our nation shall unite, many faults, both of omission and commission, will be avoided.

The decision on the part of the Imperial Commission not to recognize any representatives from the United States except through the medium of the general agent, Mr. Beckwith, rendered it extremely difficult for a State Commissioner to be of practical service.

The results of the Paris Exhibition, so far as we are concerned as Americans, have been eminently satisfactory; our proportion of prizes gained has been beyond that of any other nation, and in spite of the meagre display and bad arrangement, the striking points in the American department have had a telling effect, which will hereafter prove very valuable to the progress of the entire country. As a whole, the United States is specially indebted to the Commissioners from the Western States, who, prepared with maps and documents, have given a most complete idea of the grandeur and extent of our country.

This has led to preparations on a large scale for emigration during the ensuing year, and thus the funds so grudgingly advanced by our government will be repaid a thousand fold.

The State of New York, representative of the Union, as she has always stood in the eyes of the Old World, must derive practical advantage from this greatly increasing current of immigration, and those ties commercially and financially uniting our great city with the monetary centres of Europe, have become more strongly knit by this interchange of inventive genius and skill.

The State itself has been well represented, and while all its citizens feel a sincere regret that public duties prevented the fulfillment of your early expressed wish to be present during the progress of this epitome of the world's industry, at the same time they are gratified that the Lieutenant-Governor, as your representative, has had so full an opportunity from personal examination to present at home his views upon the advantages to be derived therefrom.

So far as the exhibits from the State of New York are concerned, they have been exceedingly creditable, and present a favorable proportion both in number and in results, compared with other States.

For the purpose of reference I beg leave to submit herewith, "Appendix A," a tabular statement of the total number of exhibits from the United States, arranged in States; and also "Appendix B," a catalogue, as complete as possible, of the names of those specially representing the State of New York, with the results of each exhibitor, so far as regards awards of prizes, &c.; the only source of information which I have had for these reports, is the last edition of the official catalogue of the United States department, and if there should be errors in the names or awards, I

trust that they will not be ascribed to your Commissioner.

In art, New York stands preëminent; such names as Church, Bierstadt, Elliott, Boughton, Durand, Johnson, &c., &c.—household words with us—have taken a hold upon the taste and criticism of the Old World that the award of the jury very poorly indicates. In this connection it will not be amiss to refer to the additions made from the works of foreign artists by the merchant princes of our city to their already valuable art galleries.

It is well known that had there been some representative of our artists present, many orders would have been secured from the favorable impressions made upon European connoisseurs.

In statuary, Mr. Thompson has made for himself a place in the hearts of the French people by his admirable representation of the First Emperor.

It is much to be regretted that the section of "Materials and their application in the liberal arts," Group II, should have been so very limited, especially in the department of printing; with the knowledge in Europe of Hoe's printing press, and the great development in rapidity and execution in our book and job printing offices, a fair exhibit of a New York printing office in action would have been in every respect gratifying.

The specimens of typography exhibited by Messrs. Baker & Godwin, of New York, attracted much and well-merited attention and commendation; the books on exhibition were unfortunately in closed cases, and thus favorable opportunities for examination were

wanting. Special reference must be made in this connection to the specimens of bank note printing exhibited by the American Bank Note Company, of New York, and which were universally admired.

It will be seen that Messrs. FAIRCHILD & Co., of New York, received a bronze medal for their gold pens, an article but little known in Europe. The samples of lead pencils from the American Lead Pencil Company, of New York, have given occasion to much comment as the opening up a new source of supply for an article heretofore nearly controlled by Prussia.

As specimens of design, the charming groups of statuettes by Rogers, did not fail to reach the hearts of all, and great surprise has been expressed that they should not have received some notice, for they were certainly the first of their class in the entire Exposition. Scientific writers upon the Exhibition, in the department of photography have given special praise to the photographs of the moon, presentedby L. M. RUTHERFORD, Esq., of New York, whose labors in that direction well merit the award of a silver medal.

In musical instruments the great piano contest has excited too much attention to require comment here. It is specially gratifying to us as Americans to know that the rivalry is entirely between representatives of our own country, and not from any fear of foreign competition.

The cornets of SCHREIBER, of New York, have attracted much favor, and his system stands a fair chance of being adopted.

In surgical apparatus special note must be made of that exhibited by Dr. C. F. TAYLOR, of New York,

which, from its ingenuity and great value, received special commendation in a lecture before the surgeons of Paris.

Among instruments of science, the beautiful and accurate aelloscope, exhibited by Professor CLUM, of Rochester, stands preëminent. It has been secured for the Conservatoire des Arts et Métiers, of Paris.

PHELAN'S billiard table was always the centre of attraction, and in its class stood superior to any other on exhibition. The new process of bronzing, as applied to iron, and exhibited by H. TUCKER & Co., of New York, received a silver medal. This process is considered a great economy in the appliance of art to the beautifying of objects used in every day life.

The great increase in the use of petroleum in Europe renders any improvement in the lamps and processes of burning, a great desideratum, and for that reason the exhibition of IVES & Co., of New York, deserves mention as combining advantages far in advance of any European invention. The machine-sewed boots and shoes of E. C. BURT, New York, were awarded a silver medal, as entirely unique in their character and quality.

A special report to the United States government, by your Commissioner, indicates very fully the high position occupied by our country in the department of fire-arms, but special mention must be given here to such exhibits as were made by citizens of New York. The REMINGTON and BERDAN breech-loaders have been received with great favor in Europe, and the large orders forwarded to their respective makers, indicates the superiority over the arms presented by other countries.

In ordnance, the breech-loading wrought-iron cannon of Mr. G. FERRIS, of Utica, deserves notice. No single arm in the Exposition has attracted so great attention as this; its long range and power, with capacity for fully burning an extraordinary charge of powder, gives it an apparent superiority over all other ordnance, and reports upon its availability have been ordered by nearly every government.

New York, in minerals, is represented by specimens of iron, magnetic iron ore, franklinite, mica, feldspar, beryl, quartz and white-lead. The stuffed animals of GUNTHER, and the stuffed birds of BELL attracted much attention.

In the Annexe, the Stearn Stone-Cutter Company, of New York, had a model of their stone-channeling and quarrying machine, which has been received in Europe with great interest; in the stone-quarries near Paris, it will prove specially valuable. The WOOD mower and reaper, from Hoosick Falls, N. Y., was experimented with at the Emperor's farm, with most favorable results, receiving a gold medal.

The hay-tedder, exhibited by Mr. S. C. HERRING, of New York, also proved to be in strong competition with European inventions of a similar character.

SCHULTZ & WARNER exhibited a soda-water apparatus and fountain of great merit.

In the department of machinery, New York is represented by the HICKS steam engine, ANDREWS' centrifugal pump, DART'S rotary engine, JONES' piston packing, PICKERING'S engine regulator, STEARN'S syphon pump, PEASE'S petroleum pump, ROPER'S hot-air engine, ERIC-

SON'S hot-air engine, BRYANT'S grinding mill, ROOT'S trunk engine, etc., etc.

As usual, the sewing machine department was almost entirely filled with representatives from our State, and their success has already been well heralded through the public press. It has been estimated that there has been a daily sale of not less than fifty sewing machines during the continuance of the Exposition.

The serpentine wood moulding machine of WINSLOW arrived too late to receive the notice which it merits. The compressing machine of SWEET, and WELCH'S machine for dressing printing types, have been largely commented upon by the public press. In telegraphy, as is well known, a grand prize was awarded to citizens of New York, CYRUS W. FIELD, and DAVID E. HUGHES. It is to be regretted at the same time that a similar prize was not given to Professor S. F. B. MORSE, the inventor of telegraphy, and who is also a citizen of New York.

The model of a canal without locks, exhibited by HORACE H. DAY, New York, is considered a most valuable invention. It has been reported on to several governments.

The building blocks of G. E. VANDERBERGH, of New York, have been quite universally adopted as the most economic material exhibited.

The great safe contest between SILAS C. HERRING, of New York, and an English safe manufacturer, has brought forward so very forcibly the ability of our inventors and mechanics, and the energy of our people, that I feel it quite proper to present the report of the jury.

The following is the concluding portion of the report of the committee on the great international safe contest, drawn up by M. PAUL DOULIOT, the president, and translated by M. ALBERT DE ——:

"Admitting the excellence of both the safes submitted to trial, and also admitting the force brought to bear upon them was far superior to any ever likely to be employed by burglars, a careful consideration of the facts compels us to the following conclusions:

"Firstly: That considering the intrinsic quality of the different materials employed as being equal in the two safes, Mr. HERRING has, by his happy combination, rendered the material more efficacious, and indeed given to the hard cast-iron the tenacity which it lacks by nature, and we are therefore of opinion from this point of view:

"1. That Mr. HERRING'S safe is the better in quality of the material employed.

"2. That the exterior aspect of the CHATWOOD safe, from the closeness of its joints and simplicity of its form, would disincline burglars to attack it; but if they should have the security necessary to make the attempt, its too great uniformity of constructive detail would give them great hope of success, their difficulties would considerably diminish as they proceeded, and this would act as a moral stimulant to their physical force, until they attained the prize they coveted.

"The HERRING safe, which appears at first more easy of attack, presents to the end difficulties always great, and always varied, and never shows signs of an approaching success; it therefore tends to exhaust both the physical and moral energy, and to this extent offers a superior guarantee against the successful attack of burglars.

"We are therefore of the opinion that the HERRING safe is the best in its capability of resisting drilling instruments, gunpowder, steel wedges, crowbars, steel screws, or any other kind of burglars' appliances.

"We, therefore, in accordance with the foregoing decision, direct that the 15,000 francs deposited by Mr. HERRING be returned to him, and that the 15,000 francs deposited by Mr. CHATWOOD be applied, first to the necessary expenses of the trial, and that the

balance, divided into three equal portions, be given to the charities of London, Paris and Washington, as directed by Mr. HERRING.

"In consequence of the course taken by the English members of the committee, and in order to place ourselves beyond all suspicion or question, we hereby request M. TAGNARD to be good enough to charge himself with the naming of the amount to be paid to the different members of the committee for their professional services.

"Accordingly we have signed the present document, the 5th day of October, 1867, in the presence of Mr. BECKWITH, United States Commissioner-General of the Universal Exhibition, and Mr. CHEYSSON, Chief of the Delegated Service.

[Signed] "PAUL DOULIOT, *President*,
"JOSEPH E. HOLMES,
"THOMAS R. PICKERING,
Committee.

"W. J. HOYLE, *Secretary.*
"S. CHEYSSON, *Chief of the Delegated Service.*
"N. M. BECKWITH, *U. S. Commissioner-General.*"

The following is an extract from the original contract between the parties to the contest:

"And the said SILAS C. HERRING and SAMUEL CHATWOOD agree, by these presents, to accept the decision of the committee, when it shall be given in writing, bearing the signature and seal of at least three members of the said committee.

"Done, in duplicate, at Paris, this 9th day of July, 1867.

"I approve the document above set forth, and I acknowledge it as my engagement.

[Signed] "SILAS C. HERRING.

"I approve the document above set forth, and I acknowledge it as my engagement.

[Signed] "SAMUEL CHATWOOD."

J. B. VANDEUSEN, of New York, has presented a model of the yacht "Fleetwing," of which copies and designs

have been made for various parties, as the best model on exhibition.

The life-saving raft of E. F. PERRY, while on exhibition was most thoroughly tested, and the voyage of the "Nonpareil," built on the same model, has given it great prestige and prospects of success.

The Glen Cove Company of New York, have made a great success with their preparation of Indian corn, or maizena. This article, it is believed, will work a positive change for the better in the food of European nations. As an economy, the growth of Indian corn is being facilitated in France in every possible manner, and the maizena has been largely introduced into the leading restaurants and hotels. Much credit is due to Mr. W. J. TOWNSEND, in this connection, for the able manner in which he has presented the merits of Indian corn as an article of food.

The extract of beef of GAIL BORDEN has attracted more attention and comment than any other system of preserving beef on exhibition. It is considered far superior to the preparation of LIEBEG, and very large orders have been given for it from different parts of Europe.

In this brief report, attention has been given to a majority of the articles exhibited by citizens of New York, and the proportion, as compared with other States, is certainly a gratifying one.

In a careful examination as to what subject in the Exposition would bear a special report, in connection with its practical value to our State, the undersigned has selected that of "Fortification, as applicable to the needs of the city of New York." As Commissioner

upon War Material from the United States government, he has had special advantages in examining plans and details, and the accompanying statements, with drawings, are submitted to the consideration of yourself and the Legislature.

In conclusion, your Commissioner would beg leave to call your attention to the subjoined list of Catalogues, "Appendix C," and publications relative to the Exhibition, which he begs leave to donate to the State Library at Albany.

With sincere thanks to yourself, for the high honor conferred upon me of representing the "Empire State,"

I am, sir, most respectfully,

Your obedient servant,

CHARLES B. NORTON,

Colonel and A.D.C., N.G., S.N.Y.,

Commissioner from the State of New York to the Paris Exposition of 1867.

APPENDIX.

(A.)

TABULAR STATEMENT OF AWARDS TO AMERICAN EXHIBITORS AT THE PARIS UNIVERSAL EXHIBITION OF 1867.

STATES.	Grand prize.	Gold medal.	Silver medal.	Bronze medal.	Honorable mention.	Total.
New York	2	7	21	31	39	100
Massachusetts	.....	1	14	13	11	39
Illinois	.....	1	7	2	1	11
Pennsylvania	.....	2	5	14	7	28
Rhode Island	.....	1	3	1	.....	5
New Jersey	.....	1	3	1	.....	5
Maryland	.....	.....	2	2	3	7
California	.....	.....	3	2	1	6
Wisconsin	.....	.....	.....	4	2	6
Ohio	.....	.....	.....	1	6	7
Connecticut	.....	1	2	6	5	14
Florida	.....	.....	.....	.....	.....	.....
Kentucky	.....	.....	.....	1	.....	1
Missouri	.....	.....	.....	.....	3	3
Louisiana	.....	2	3	4	5	14
Michigan	.....	.....	.....	1	.....	1
Alabama	.....	.....	1	.....	2	3
Iowa	.....	.....	.....	.....	1	1
Vermont	.....	.....	2	2	1	5

Indiana	1		1
Minnesota		1	1
Arkansas			
Kansas	1	1	2
Nevada			
Georgia			
Virginia	2		2
Utah			
South Carolina			
West Virginia	1		1
New Hampshire	1		1
Maine	1	1	2
Mississippi			

The other States have not exhibited.

(B.)

AWARDS TO THE EXHIBITORS OF THE STATE OF NEW YORK AT THE PARIS UNIVERSAL EXHIBITION, 1867.

EXHIBITORS.	RESIDENCE.	ARTICLES EXHIBITED.	Grand prize.	Gold medal.	Silver medal.	Bronze medal.	Honorable mention.
Cyrus W. Field	New York	Trans-Atlantic telegraph	1				
David E. Hughes	do	Printing telegraph	1				
Steinway & Sons	do	Pianos		1			
Chickering & Sons	do	Pianos		1			
W. D. Walbridge	do	Samples of gold, silver, tin and copper		1			
W. A. Woods	Hoosick Falls	Mowing and reaping machine		1			
Wheeler & Wilson	New York	Sewing machines		1			
Elias Howe, Jr.	do	Sewing machines		1			
P. Welch	do	Machine for dressing type		1			
F. E. Church	do	Landscape painting			1		
L. M. Rutherford	do	Photographic views			1		
Mason & Hamlin	do	Cabinet organs			1		
H. Tucker & Co.	do	Bronze work			1		
New York Mills	do	Fine muslins			1		
Edwin C. Burt	do	Boots and shoes			1		
E. Remington & Son	do	Firearms			1		
Gunther & Son	do	Stuffed animals			1		
F. S. Pease	Buffalo	Lubricating oils			1		

Steam Stone Cutter Co	New York	Stone-cutting machine			1			
Collins & Co	do	Steel plows			1			
Shultze & Walker	do	Soda fountain apparatus			1			
Cool, Ferguson & Co	Glens Falls	Barrel machine			1			
M. Opper	New York	Power loom			1			
J. W. Lamb	Rochester	Knitting machine			1			
Florence Sewing Machine Co	New York	Sewing machine			1			
Weed Sewing Machine Co	do	Sewing machine			1			
Wood Brothers	do	Phæton			1			
Glen Cove Starch Manufacturing Co.	do	Maizena			1			
Cape, Culver & Co	do	Manhattan hams			1			
G. Tieman & Co	do	Surgical instruments			1			
D. Appleton & Co	do	Books					1	
Secombe Manufacturing Co	do	Stamps					1	
L. W. Fairchild & Co	do	Gold pens					1	
American Lead Pencil Co	do	Lead pencils					1	
S. Beer	do	Stereoscopic views					1	
G. Gemunder	do	Stringed instruments					1	
Schreiber Cornet Manufacturing Co.	do	Brass instruments					1	
A. J. Johnson	do	New illustrated family atlas					1	
W. H. Townsend	do	Oil cloths					1	
Tiffany & Co	do	Silverware					1	
H. Stursbury	do	Cloths					1	
S. H. Randall	do	Specimens of mica, quartz, &c.					1	
Douglass Manufacturing Co	do	Edge tools					1	
C. H. Lilienthal	do	Snuff and tobacco					1	
H. G. Hotchkiss	Lyons	Samples of essential oils					1	
L. B. Hotchkiss	Phelps	Samples of peppermint and spearmint oils					1	

AWARDS—CONTINUED.

EXHIBITORS.	RESIDENCE.	ARTICLES EXHIBITED.	Grand prize.	Gold medal.	Silver medal.	Bronze medal.	Hon'ble mention.
Pickering & Davy	New York	Steam engine regulator				1	
J. B. Root	do	Root's trunk engine				1	
C. L. Goddard	do	Mestizio burring picker				1	
A. J. House	do	Co-operator				1	
A. H. House	do	Co-operator				1	
J. E. Sweet	Syracuse	Type composing machine				1	
Degener & Weiler	New York	Printing presses				1	
Herring, Farrell & Sherman	do	Safes, fire and burglar proof				1	
J. B. Van Deusen	do	Model of American yacht "Fleetwing"				1	
Brown & Level	do	Tackle for disengaging ships' boats				1	
W. S. Carpenter	Harrison	Indian corn in the ear				1	
McP. & D. Smith	New York	Pale ale, porter and brown stout				1	
Dr. E. D. Hudson	do	Artificial limbs				1	
Cummings & Son	do	Hospital wagon				1	
Willard & Co	do	Photographic camera tubes and lenses					1
W. Selpho & Son	do	Artificial limbs					1
J. Allen & Son	do	Artificial teeth					1
C. F. Taylor	do	Therapeutic apparatus					1
Kaldenberg & Son	do	Meerschaum pipes					1
Williams Silk Manufacturing Co	do	Silk twist for sewing machines					1
W. O. Linthicum	do	Spring overcoat					1
J. H. Jackson	do	Minerals and fossils					1

Goodenough Horse Shoe Co	New York	Horse shoes	1
Lalance & Grosjean	do	House furnishing, hardware, &c	1
L. Elsberg	do	Prepared peat fuel	1
F. S. Cozzens	do	Segars	1
T. & C. Holliday	do	Dyes, pigments, colors and chemicals	1
C. Korn	do	Calf-skin leather	1
Metropolitan Washing Machine Co.	do	Clothes wringer	1
J. Ward & Co	do	Clothes wringer	1
G. Punington, jr	do	Carpet sweeper	1
J. Prentice	do	Segar making machine	1
Hicks Engine Co	do	Steam engines	1
W. D. Andrews & Brother	do	Centrifugal pump and oscillating engine	1
H. C. Dart & Co	do	Behrens patent rotary engine and pump	1
Steam Syphon Co	do	Steam syphon pump, RR. station pump	1
Broughton & Moore	do	Oilers, cocks, &c	1
F. S. Pease	Buffalo	Pump for petroleum	1
J. A. Robinson	New York	Erricson's hot air engine	1
Clark's Steam and Fire Regulator	do	Steam and fire regulator	1
Empire Sewing Machine Co	do	Sewing machines	1
J. B. Winslow	do	Serpentine wood moulding machine	1
C. Wellman	do	Ladies' and gentlemen's saddles	1
E. W. Page	do	Oars	1
Gail Borden	do	Extract of beef	1
Townsend & Brothers	do	Canned oysters	1
Oneida Community	do	Preserved fruits	1
C. C. Williams	do	Hermetically sealed fruit in syrup	1
Pleasant Valley Wine Co	Hammondsport	Sparkling wines and brandy	1
Dr. B. Howard	New York	Ambulance and relief material	1

(C.)

LIST OF BOOKS AND PAMPHLETS PRESENTED TO THE NEW YORK STATE LIBRARY BY COL. CHARLES B. NORTON, NEW YORK STATE COMMISSIONER TO PARIS UNIVERSAL EXPOSITION, 1867.

No.	Country.	Catalogue of Books and Pamphlets.
1....	Wurtemburg	Catalogue descriptif des produits du Royaume de Wurtemburg.
2....	Bohemia	Catalogue des fossiles du système Silurien du centre de la Bohemia, de la collection de J. M. Schary, de Prague.
3....	Bavaria	L'Industrie de la Bavière à l'Exposition à Paris, 1867.
4....	France.....	Almanach de l'Exposition Universelle, 1867. Guides des Exposants et des visiteurs.
5....	Baden	Les Exposants du Grand Duché de Bade, et leurs produits.
6....	Nevada	La Nevada Orientale, Geographie, Resources, climat, et état social.
7....	Hesse.....	Catalogue spécial du Grand Duché de Hesse.
8....	Austria	Les Richesses forestières de l'Autriche, et leur exportation.
9....	Italy.....	L'Italie Economique en 1867, avec un aperçu des industries Italien à l'Exposition Universelle de Paris
10....	France.....	Notice explicative sur les différents produits et spécimens de navires et machines exposés par la nouvelle Société des Forges et Chantiers de la Mediterranée.
11....	Colorado	Das Coloradogobiet in den Vereinigten Staaten von Nord America, von J. P. Whitney.
12....	Italy.....	Regno d'Italia. Esposizione Universale del 1867. A Parigi. Parte prima.
13....	Spain	Expozicion Universal, 1867. Seccion Espanola.
14....	Roumania	Notice sur la Roumanie, principalement au point de vue de son économie rural, industriel et commercial, avec une carte de la principauté de Roumanie, Exposition, 1867.
15....	England.....	Complete official catalogue—English version—published under authority of the Imperial Commission.
16....	France.....	Rapport sur l'Exposition Universelle de S. A. I. le Prince Napoleon, 1855.

17....	England	Catalogue of the British Section, Universal Exposition, 1867.
18....	Italy	Reale Comitato dell' Esposizione internazionale del 1862, Relazioni dei commissari speciali; (4 vols.)
19....	Italy	
20....	Italy	
21....	Italy	
21½...	Germany.....	Katalog der Œsterreichischen Abtheilung Herausgegeben von K. K. central comite fur die Pariser Austellung.
22....	Germany.....	Die industrie und landwirthschaft, Bayerns auf der internationalen austellung zu Paris, im jahre 1867.
23....	Hesse.....	Catalogue spécial du Grand Duché de Hesse, publié par la Commission Grand Ducale.
24....	Wurtemburg	Descriptive catalogue of the Kingdom of Wurtemburg, published by authority of the Royal Wurtemburg Commission.
25....	Baden	Les Exposants du Grand Duché de Bade et leurs produits, publication de la Commission Grand Ducale.
26....	Germany	Der Spalter Hopfenbau in seinem ursprunge und Betriebe, &c.
27....	Chili	Notice statistique sur le Chili et catalogue des minéraux envoyés à l'Exposition Universelle.
28....	England	Bradshaw's Handbook to the Paris Exhibition, 1867.
29....	England	Indian department (British.) Catalogue of the articles forwarded from India. 1867.
30....	Netherlands	Catalogue spécial; Exposition Internationale, 1867.
31....	Turkey	La Turquie à l'Exposition Universelle, 1867.
32....	Sweden	La Suède, son développement moral, industriel, économique et commercial, 1867.
33....	Italy	L'Italie économique en 1867, avec un aperçu des industries Italiennes, à l'Exposition, 1867.
34....	Russia	Aperçu statistique des forces productives de la Russie; Exposition, Paris, 1867.
35....	Argentine Repub.	La Republique Argentine. Finances, commerce, industrie, lainière, émigration, chemins de fer, mines, colonies. Rapport addressé au Gouvernement de S. M. Britannique, par Francis Clare Ford, Secretaire de la Légation Britannique.
36....	Brazil	The Empire of Brazil at the Paris Exhibition.
37....	France.....	Administration des Foréts.
38....	Sardinia.....	Notice sur les mines, de l'Ile de Sardaigne.

LIST OF BOOKS AND PAMPHLETS—CONTINUED.

No.	COUNTRY.	CATALOGUE OF BOOKS AND PAMPHLETS.
39....	Sardinia.....	Catalogue général, publié par la Commission Impériale; Groupes, 1 à 10.
40....	Sardinia.....	
41....	Belgium.....	Catalogue des produits industriels et des œuvres d'Art.
42....	Portugal	Catalogue spécial de la section Portugaise, 1867.
43....	Spain	Notice sur l'état des travaux publiques en Espagne et sur la législation spéciale qui les régit.
44....	Australia.....	Vocabulaires des dialectes des Aborigènes de l'Australie.
45....	New South Wales	Catalogue of the natural and industrial products of New South Wales. Universal Exhibition, 1867.
46....	Guyana, English.	Catalogue des produits exposés par la Guyane Anglaise.
47....	England	Exposition intercoloniale. Statistiques des mines et des minéraux.
48....	Sardinia	Notice sur les mines de l'Ile de Sardaigne.
49....	South Australia..	Catalogue of contributions to Paris Exposition, 1867.
50....	Victoria.....	Notes sur la géographie physique, la géologie et la minéralogie de Victoria.
51....	Victoria.....	Progrès de Victoria, depuis 1835, jusqu' à 1866.
52....	Australia.....	Notes sur la végétation indigène et introduite de l'Australie.
53....	Queensland.....	Catalogue of the natural and industrial products of Queensland
54....	Victoria.....	Notes sur les gemmes et les pierres précieusis trouvées dans Victoria.
55....	Queensland.....	The colony of Queensland as a field for emigration.
56....	Victoria.....	Notes sur la Zoologie et paléontologie de Victoria.
57....	Algeria	Catalogue spécial.
58....	French Colonies..	Catalogue des produits des Colonies Françaises.
59....	Russia	Catalogue spécial de la section Russe.
60....	France.....	L'Exposition Universelle de 1867.

SPECIAL REPORT.

FORTIFICATIONS

AS APPLICABLE TO THE NEEDS OF THE CITY OF NEW YORK.

If there be any branch of the materials and arrangements connected with modern warfare, in the Paris Exhibition, that disappoints military men, it is that which refers to permanent fortifications. This certainly seems strange when we consider that it was the perfection of such defensive works, more than any other cause, which led to the great strides that have been made in the matter of ordnance and projectiles; and, as a necessary result, to iron-clad ships of war. Before the exigencies of our late war brought into active service the offensive weapons we possess—the production of the ingenuity of our countrymen—the genius of TODLEBEN, as exhibited at Sebastopol and Cronstadt, so baffled the armies and navies of England and France as to demand larger and more powerful guns than any then possessed by the allied powers. Many years of time, and many millions of money, have been expended in England in attempts to make cannon of wrought-iron and steel, that would be superior to our cast-iron guns, and though no really reliable iron or steel gun of large calibre has yet been produced, enough has been done to show that the entire system of permanent forts, hitherto considered efficient, will have to be changed.

Such works as those which protect the harbor of New York were in little danger, even from such improved guns, before the advent of iron-clad ships. But now, if any iron-clad could take up a position within a thousand yards of these forts, the facts and experiments hereinafter noticed and illustrated, will show how easily these works could be rendered untenable, and their guns silenced. On the other hand, it is quite clear that such works can be so strengthened and protected, at a moderate cost, that no iron-clad in existence could remain long before them without the risk of total destruction.

Before considering how such works may be so strengthened, it will be well to endeavor, by a comparison with similar structures, to ascertain what are their present capabilities for resisting heavy ordnance. Although there is really nothing in the exhibition to show how existing stoneworks may be so strengthened as to adapt them to the altered condition in which they are placed in relation to improved offensive weapons, there is much to prove how inadequate they are, in their present state, to stand against guns of even moderate power.

The French Minister of War shows photographs of various stoneworks, such as martello towers, that have been attacked by field ordnance, but no information is given of the nature and dimensions of the structures, nor of the conditions of the attack. Similar photographs are exhibited among the British munitions of war. They are photographs of the martello tower fired at by seventy pounder siege guns, during the ARMSTRONG and WHITWORTH trials; and the following

extracts are from the reports of the committee which conducted the experiments:

"The committee applied to the Secretary of State for War for the necessary means for trying the relative effects of the various projectiles when fired against earthworks, but were unable to carry on any experiments, as there was no earthwork available, in which shells could be burst with safety.

"The brickwork fired at was a martello tower for one gun, which had been built in 1804, at Bexhill, on the coast of Sussex; the total height of the tower was 31.5 feet; the diameter at the base was 46 feet and that of the top 40 feet. The platform on which the gun was intended to be mounted, was carried by a semi-circular arch, turned from a pillar in the centre of the tower, four feet in diameter, to the exterior wall, there being about five feet in thickness of brickwork, between the crown of the arch and the platform of the battery above it. Towers of this construction were the only objects available for testing the relative powers of penetration of the projectiles fired from the various guns, being the only brickwork of sufficient dimensions in the possession of the War Department, to the destruction of which there was no objection. A martello tower is not, however, an object which, from its construction, is well calculated for the experiments the committee were desirous of making. The situation of the tower, with reference to adjoining property, was such that considerations of safety precluded the committee from firing at it from any direction but one. All three guns, therefore, had to be in one battery, which was 750 yards distant from the tower, and as a consequence, the portions of the tower allotted to each gun as a target were somewhat different, and as the brickwork varied in thickness at almost every foot of its height, the difficulty of obtaining good results for comparison was much enhanced. The object of the committee not being to destroy the tower, but to obtain good relative penetration for comparison, the firing was commenced with common shell filled with sand. It appeared that these shells, fired from both the muzzle-loaders, had sufficient power to pass through the brickwork where it was 7 feet thick, the muzzle-loading ARMSTRONG shell being found unbroken inside, and the WHITWORTH shell in pieces; the shell from the breech-

loader penetrated 4.75 feet into the wall, where it was 7.25 feet thick, and 5.6 feet into the wall, where it was about 6.4 thick, cracking the brickwork inside, and knocking away three bricks of one course. A shot from each gun struck on the solid part of the tower where the brickwork is about 40 feet thick; the hollow-headed shot of the breech-loading ARMSTRONG gun penetrated three feet; the solid shot from the WHITWORTH gun passed through 7.25 feet of brickwork, having deflected downwards and broken through the crown of the arch; the hollow-headed shot from the muzzle-loading ARMSTRONG gun penetrated 4.75 feet. All the measurements of penetration were taken to their bases, where the projectiles did not pass through the wall. Only one line shell was fired from each gun with results which were capable of comparison, after which the tower became so injured that the amount of damage attributable to each round could not be recorded."

Such structures as this martello tower, even with their circular form, well adapted for resisting shot, cannot be compared with the works at Sebastopol, Cronstadt or New York; so neither can the above light pieces, with their seventy pound shot and ten pound charges, be compared with the guns which now form the armament of iron-clad navies. On the same wall, however, with these photographs of the ruined martello tower, there is shown a series of photographs of an experimental work as strong, or rather as weak, in its resistance to shot as any of the above named fortifications.

The trial of the granite casemate, represented in Plate I, commenced on the 16th November, 1865, and was conducted by the ordnance select committee, assisted by Colonel JERVOIS, R. E., and Major INGLIS, R. E., Superintendent of Works at Shoeburyness. This structure, with its area of about 1,500 feet, presented five distinct features or combinations to the

guns. First, the granite work; second, the compound shield A (Plate I); third, the solid plate shield B; fourth, the right or east wing facing C; fifth, the left wing facing D. The granite work was composed chiefly of masses of stone, of from 8 to 10 tons each. Some of the courses were 3 feet in thickness, the stones being 8 or 10 feet in length, and from 4 to 5 feet in width. The shield A, for the large embrasure, 12 feet by 8, had a front plate of 4 inches thick, and a backing of thin iron plates, 8 inches deep, their outer edges supporting the front plate, and their inner bearing on a second armor plate of 2 inches in thickness. This again rested upon a cushion of teak timber, $6\frac{1}{2}$ inches thick, the whole bearing on a skin of inch iron, and bound together by 22 bolts of 3 inches diameter, and 16 bolts of 2 inches, all having shallow square threads. The skin was attached to 2 struts by double angle bars, 6″ by $4\frac{1}{2}$″ by $\frac{3}{4}$″, and strengthened by six similar bars running at right angles to the struts. A strong ⊢ girder (Plate II, figure 1), 18 deep, strengthened the shield across the top of the embrasure.

The struts to which the shield is attached, rested upon a bottom plate of inch iron, $3\frac{1}{2}$ feet wide, and through this plate the entire mass was secured to the stonework, by 10 bolts of $2\frac{1}{2}$ inches diameter. The backing bars where cut to admit the passage of the through bolts, were bound together in bodies by the rivets *a*, *b* (Plates III, IV and V). As originally proposed, the principle was the same at the CHALMER'S target, but at the suggestion of the late iron-plate committee and the engineers of the War Department,

it was altered to the form represented in Plate III. For the compound backing or alternate layers of timber and iron of the original design, the present backing of layers all of iron, was substituted, on the ground that it was not advisable to introduce such a perishable material as timber in a permanent work. Half of the shield, therefore, has a backing of plain bars "8 by 1," and the other half has bars which match or bind into each other. (Plate II, fig. 2.)

The western shield B, designed by Major INGLIS, R. E., Superintendent of Works, was manufactured by Messrs. JOHN BROWN & Co., of Sheffield. It was simply a solid plate of $13\frac{1}{2}$ inches in thickness, with a port hole 3 feet by 2′ 4″. It has no fastenings or backing. At top and bottom it was let into the stonework about 6 inches, and in order to keep it up to its work, it was further supported by bars of railway iron imbedded in the stonework, which was fluted to receive them.

The right flank of the casemate was protected by the cramped iron facing C, generally termed "the puzzle," because the pieces of iron bind into each other in the manner of certain puzzles made of wood for the amusement of children; and the left flank D, was protected by $4\frac{1}{2}$ inch armor plates backed with timber and concrete.

The entire cost of this experimental structure, including cost of trial, was about £8,000. The battery to test the structure was placed at 200 yards distance, and consisted of the following guns:

DETAILS OF BATTERY.

Diameter of shunt.	Kind of shot.	Weight of shot.	Weight of charge.
7 inches	Steel	115 lbs.	18 lbs.
8 inches	Steel	150	22
9¼ inches	Steel	220	30
10 inches	Steel	280	36

The latter charges were increased to 41 lbs. when firing at the compound shield A. Against the stone-work, cast-iron shot only were used.

It is not necessary here to give a detailed account of the firing. The following account from an article on the "Spithead Forts," in the "Saturday Review," gives a correct summary of the result of the experiment:

"The practice on the shields exactly accorded with previous experience. The solid plate was seriously damaged, and a few more shots would have knocked it fairly away. The CHALMERS target stood well, as it has always done before; it kept out all the shots, and suffered no great injury beyond the snapping of several of the bolts. The battery was then turned upon the masonry, and though only cast-iron shot were used, the first blow fairly split a huge mass of granite far in the rear of the point of impact; still, the shot did not get through, though the ultimate fate of the structure might easily be foreseen. Two rounds from the four gun battery were then completed. Of the eight shots, one missed altogether, but the other seven struck the granite walls. Upon examination, it was found that a great part of the casemate was a heap of ruins, and that one of the shots had forced a clear passage into the interior of the work. The conclusion is that seven well directed shots, from the range of one thousand yards, will suffice to annihilate the projected Spithead forts, and that all the labor and money bestowed upon the works will have been thrown away, unless some better material than granite can be found

for their construction. * * * * * It seems pretty clear that the granite gave way, less from the destruction of its face than from the want of elasticity, which made the whole mass crack and fall to pieces under the blows to which it was subjected. An iron facing, unless backed by wood, and converted into armor strong enough to need no further backing, would do very little to break the shock upon the inner wall of stone, and there is scarcely room to doubt that the first experiment upon it has finally settled the fate of granite as a material for a first class fort."

Regarding the comparative resistance of the shields and the stone work, the ordnance select committee says: "After the stonework was a mass of ruins, both the shields were still capable of resisting shot, and protecting the guns in the casemate." This, however, was the case with the east shield only, for the west, or thick-plate shield, not being self-sustaining, kept its upright position solely by the masses of fallen granite, both inside and outside the casemate. Leaving for a moment the comparative merits of heavy and light iron plates, as a means of resisting shot, let us see the effects produced on the stonework by the aforesaid guns. This will be seen by a glance at the wood cut (Plate VI), copied from a photograph taken after 65 shots had been fired at the entire work, namely: 11 of steel at the east shield; 8 of steel, and 1 of cast-iron on the west shield, and 45 of cast-iron on the stonework, distributed as follows: 11 on east pier; 11 on east arch; 10 on west pier; 10 on west arch, and 3 on centre pier. These 45 rounds, with an average charge of $26\frac{1}{2}$ lbs. of powder, and average weight shot of $191\frac{1}{4}$ lbs., give, for each round, an average of 2,142 foot-tons of work, or a total work of 106,390 foot-tons, which is considerably

less than that of two discharges from the broadside of the English iron-clad "Warrior," with her new armament.

Although the shields were designed only to protect the guns in the granite casemate, and would have been rendered useless by the destruction of the main portion of the work, the experiments against them, inconclusive though they were, will aid in forming an estimate of the relative value of thick and thin plates of iron for permanent fortifications, whether such plates may be used to protect existing works, or in new and independent structures.

The only newspaper report of these trials which appeared at the time was in the "Army and Navy Gazette," from which we extract the following paragraph:

"The experiments on Thursday were confined to testing the shields, both of which proved a perfect defence against the 7-inch and 8-inch guns. The small or thick-plate shield, however, was cracked on one side by the first blow from the 9-inch gun, and the 10-inch or 300-pounder broke it right across, virtually placing it *hors du combat*. Another shot would have driven it into the casemate, but that — perhaps to save the feelings of its projector (the superintendent of works) — was withheld. No such merciful treatment, however, was afforded to the shield of the outsider, for when it did not succumb to the ordinary charges, the charges were increased to 41 lbs., and the firing continued until it was severely punished. At the conclusion, the fastenings were nearly all destroyed, but no shot had penetrated the target, nor was it displaced by the heaviest firing ever seen at Shoeburyness. The thick-plate shield, which was virtually disposed of at the fourth round, was struck by a total of 765 lbs. of metal, propelled by 106 lbs. of powder; whilst the built-up, or CHALMERS shield, resisted 2,445 pounds of metal, and 311 lbs. of powder."

The statement here made that "the fastenings were nearly all destroyed," is not strictly correct; about a dozen bolts out of 38 had snapped, but there remained up to the close of the experiment, enough to keep the plates in position. The iron used for these bolts was not at all suited to the work; it was fine grained, Low-moor iron, which is too much of the nature of steel to stand the vibration arising from the impact of heavy shot.

The effects produced on the thick plate or west shield are, to some extent, hidden in the wood cut, by the debris of stonework. They are, however, faihfully illustrated in the wood cut (Plate VII), which represents the plate as it now stands in the exhibition. The shield was designed, as before stated, to protect a gun in the experimental granite casement; it is 8 feet high and 6 feet wide, and has an embrasure (3 feet 6 inches in height, and 2 feet 4 inches wide) rounded off at the corners, and slightly beveled on the inside to facilitate the training of the gun. It is necessary to state these points precisely, because it has been often alleged that this shield would not have been broken, had not the cutting out of the large port-hole so weakened it, as to facilitate its destruction. There can be no doubt that the embrasure weakened the plate, but fortifications must have openings to train their guns through. This, however, is not the point now under consideration; the question is, can heavy shot at high velocities be met and successfully resisted at the point of impact, or must they be received and allowed to expend their energy on, or rather in, some exterior protection, before they reach

the vital part of the work attacked? Keeping this question in view, let us see what prospect mere thickness of iron holds out of obtaining reliable protection. The "Thorneycroft-bar" shields, made for the defence of Cronstadt, gave good results under the impact of what, in England five years ago, was considered heavy shot, namely, 68-pounder and 110-pounder projectiles; but such shot as those of the 15-inch RODMAN would break these grooved and tongued bars like so many reeds. Those used at Cronstadt are 10 or 12 inches thick, and 15 inches in depth of structure, having a dove-tailed projection on each bar for the purpose of securing it to the framing of the permanent work, as represented in Plate II, fig. 3.

Another method adopted by the Russians, was to face the existing stoneworks with a certain thickness of iron plates, and to use plates of greater thickness to protect the embrasure of the casemate. These plates were manufactured chiefly by Messrs. JOHN BROWN & Co., of Sheffield, and one of them was taken to Shoeburyness to be tested, before the lot was shipped off to Russia. This plate was about 17 feet long, $4\frac{1}{2}$ feet wide, and 11 inches thick. About 3 feet at each end rested upon, and was firmly bolted to great beams of timber, which were placed against the face of an old iron target; thus about 11 feet of the length of the plate was unbacked. It was fully expected that this thickness of solid iron would have successfully resisted any projectile then in existence; and doubtless, such would have been the issue, did penetration alone result from the impact of heavy shot moving at high velocities. But the work or energy in the projectile

developed itself in a manner quite unexpected. This will be perceived from a single line from the official record of the firing, for a single shot sufficed to destroy the plate. "The range was 200 yards; the charge of powder, 90 lbs.; 13.3-inch gun, weighing 22 tons; spherical steel shot, weighing 344.4 lbs.; velocity, 1,574 feet; work in foot-tons, 5,916."

Effects—Shot struck centre of plate, indent 4.9 inches; plate broken in two, and pieces thrown six feet apart.

The plate was split longitudinally into two equal parts as if it had been a lath. It is not necessary to add a single word to these facts, to show how unwise it would be, in the case of permanent works, to trust to mere thickness of iron or to turreted and other structures, composed chiefly of thick iron plates, which can thus be placed *hors du combat* by a single blow. It must also be borne in mind, that such ships as the British iron-clad "Hercules," "Monarch," or "Captain," could each fire four such guns as the above in salvo. The Russian thick plate, at least, was not weakened by a port hole, and may be taken as fairly representing the strongest part of any structure hitherto erected, which aims at meeting and defeating the projectile at the point of impact. We shall now more minutely consider the trial of the 13½-inch shield. This plate, if weakened by a port-hole, was 2½ inches thicker than the Russian shield, and had the advantage of being secured at the ends in massive masonry, and supported in the rear by a series of fluted iron bars, about 18 inches in depth, let into the lintel and sill of the embrasure, and extending several

feet into the stonework on either side. The following is a table of the rounds fired at this shield, the range being 200 yards:

DETAILS OF ROUNDS FIRED.

Round.	Gun.	Usual charge.	Charge employed	Weight of shot.	Kind of shot.	Work in foot-tons.
No. 1	7 inch	22 lbs.	18 lbs.	115 lbs.	Steel	1,411
No. 2	8 inch	30	22	150	Steel	1,676
No. 3	.....	.....	.....	.....	.....	.....
No. 4	9¼ inch	45	30¼	222	Steel	2,662
No. 5	10 inch	50	36	285	Steel	2,827
No. 6	.....	.....	.....	.....	.....	.....
No. 7	9¼ inch	45	39½	221	Steel	3,010
No. 8	.....	.....	30¼	217	Cast iron	2,500

The work in round No. 8 was expended chiefly on the shot itself, whilst rounds Nos. 1, 2 and 3 served only to make up the total of metal fired, without doing much damage to the shield. The actual work done on the shield was, therefore, the result of rounds Nos. 4, 5, 6 and 7. Of these, No. 6 struck on the lower right hand corner, the strongest part of the shield, and No. 7 struck on the upper corner, and glanced into the port-hole, expending its work on the gun and carriage inside. There remain, then, only two rounds, Nos. 4 and 5, which chiefly did the damage illustrated in the wood cut; one cracked the right side, and the other the left, clean through, so that the shield is now held together by dowels, of three inches diameter. There can be little doubt that a single shot, like that fired at the Russian plate, with its stored up work of 5,900 foot-tons, would (striking where rounds Nos. 4 or 5 struck) have sent

the shield, broken in two, into the casemate. What, then, would be the effect on such a shield of a steel shot from the 15-inch RODMAN gun, with 100 lbs. of powder, and a *vis viva* of more than 7,000 foot-tons?

Four rounds, with 100 lb. charges, have recently been fired from this gun at Shoeburyness, two of them at one of the strongest targets ever constructed in England. This target consisted of a facing of 8-inch solid plates of wrought iron, upon a backing of 18 inches of timber in two layers, one horizontal, and the other vertical; these in turn rested upon an iron skin of $\frac{3}{4}$-inch plates. In rear, this plating or skin was supported by iron frames 10 inches deep, and 12 inches apart, which were formed of angle bars, and strongly riveted to $\frac{3}{4}$-inch skin. There were, besides, several horizontal stringers of angle iron among the timbers of the backing, which were also riveted to the skin on the front side, forming the entire structure into a massive iron girder, which was finally supported on the rear by heavy diagonal timber framing. It will be seen by a glance at the annexed sketch (Plate VIII) of this target, that its chief strength lay in the 8-inch solid plate, and as this was placed in the front, it had to meet the full force of the shock. The structure, therefore, was in the position of an army, whose main strength is unwisely placed in one line, leaving the supports and reserve too weak to profit by the resistance offered by the front. The following account of the firing, from an eye witness, will show what those who fancy they can *meet* and stop such shot at the point and moment of impact, have to contend with:

"The gun was loaded with 100 lbs. of American No. 7 cannon powder, and with a spherical cast-iron shot, weighing 453½ lbs. * * * * * The gun was placed at a distance of 70 yards, and pointed directly at the target. The shot smashed and utterly ruined the corner of the target on which it struck. The core formed by this shot was found about 60 yards in rear of the target, and in a direct line with the hole. Two masses of the plate, each weighing about 600 weight, were respectively forced 20 or 30 yards behind, and smaller pieces lay in a shower upon the ground. Four balks of timber were more or less destroyed; a piece of the inner skin, about the size of an ordidary tea-tray, was carried away, and one strut of timber behind was demolished utterly, while three others had suffered somewhat. It was, in fact, such a hole as no efforts of a crew on board ship could effectually stop.

"The result of the next round was still more disastrous. Its striking velocity was 1,535 feet per second against 1,520 in the case of No. 1. It struck the plate in the best place, punched a clean hole through it, smashed in, passing through the hole, drove the ribs and the inner skin at right angles to the skin, and propelled the piece of the 8-inch plate, which it punched out, some 20 yards to the right, whither it had glanced off some heavy bars of pig-iron a little in the rear of the target. This piece of plate proved on examination to be one of the best specimens yet found."

We have seen that the protection afforded by 13½-inch solid plates, perforated for guns, or that afforded by 11-inch plates, without such perforation, does not come up to the standard of resistance demanded in a first class fort, such as those that defend the harbor of New York. The third structure—the 8-inch warrior target—is considered equal (in resistance to shot) to the 12½ inches of solid iron plating. Now these three experimental structures, are each of them, much stronger than the shields lately sent to Gibraltar and Malta by the British War Department. The records of these experiments, however, are

chiefly instructive in showing the unreliable nature of any permanent work that has its main element of defence placed wholly in front, the point where the attacking projectile delivers its entire work unimpaired. The Gibraltar and Malta shields are different from any of the abovementioned constructions, and represent another of the theories for stopping the projectile at the point of impact. The word "theories" is here used advisedly, because the design embodied in these shields has never been tested, in any target, by heavy ordnance, nor has any official report of the experiments, with light ordnance, to test this system of construction, been allowed to go before the public. This, however, the present Secretary of War is determined to remedy, and one of the shields has been ordered to Shoeburyness for trial. The wood cut (Plate IX), represents this plan, which was designed by Colonel INGLES, now on the "defence committee," and long Superintendent of Works at Shoeburyness. The laminations of iron *a*, *b*, *c*, have thin sheets of lead between them to deaden the vibration, and the structure (12 inches in thickness) is bound together by bolts and nuts with very thick india-rubber washers.

At the first trial of this shield the bolts, 3 inches in diameter, snapped like pipe-stems, under the blows of 68-pounder and 150-pounder shot, but the committee were very lenient with their fellow officer, and allowed another bolt (there was a good supply on hand) to be put in and screwed up before the firing was renewed. It is speaking very much within the

mark to say, that a single shot such as that fired at the 11-inch plate, or the 8-inch Warrior target,* would shatter the Gibraltar and Malta shields to pieces and drive the fragments into the casemate.†

These and the new shields making for the defence of Plymouth, are thus referred to by the "London Standard," an organ of the present government:

"Let us compare the powers of resistance to shot of these Russian shields with the Plymouth laminated shield just commenced. The powers of resistance are, taking an inch plate as the unit, respectively, Plymouth, 75; Fort Constantine, 225; Russian shield under contract, 310; or in other words, the forts at Cronstadt, are more than three or four times stronger than those our authorities are erecting, and producing for the self-protection of the very country that manufactures the Russian defences. We are not quite sure to within half an inch or so of the Gibraltar and Malta laminated shields, but we believe the armor layers are 5, 5½ and 1½ inches, making a total of 12 inches. The resistance would thus be by the like estimation made for the Plymouth and Russian forts as something more than 57."

In another issue the same journal, on the same subject, descants as follows:

* The size of this shot as compared with the thickness of the target is shown in the wood cut at *d*, Plate VIII.

† Since the above was written the shield referred to has been twice tested. At the first trial, two rounds only, were fired from the 9-inch Woolwich gun, with the reduced charge of 37 lbs., the usual charge being 43 lbs. The results were 19 three-inch bolts broken, and the shield otherwise badly shaken. At the second trial, after the shield had been repaired and various methods resorted to for the purpose of saving the bolts (such as boring out the holes to the diameter of 4 inches, and surrounding the bolt with wood casing), the same gun was fired, with the full charge, and the shot completely penetrated the target. A shot from the 15-inch RODMAN

"It will also be most desirable that the new experimental section of the Spithead forts, promised in the House of Commons on Thursday, by the Secretary of State for War, should have a pounding from the RODMAN. It ought also to be fired at with an American 1,087-pounder, as in the event of its being required to attack iron shielded forts our trans-Atlantic friends would very soon find out a way to work these heavy guns aboard ships. Lord ELCHO was absolutely right in insisting on a perfect section of the new forts, and not a mere iron shield; for so unworkmanlike is the proposed stepping of the new shields upon their granite basements, that there is little doubt that such 20-inch projectiles would drive back the whole casemate like a box, if it had strength enough in its combination of parts to hold together, or otherwise, as is most likely, would knock the whole fabric down as a child's ball would a card house. We have no desire to overrate the power of American artillery, or that of any other country; indeed, the power of a weapon has, after the numerous scientific experiments which have been made, become a matter of arithmetical or algebraical calculation. Given the charge, the weight of shot, the velocity, it is easy enough to estimate the working power or destructive force for any distance of the flight from 50 to 5,000 yards. And given the thickness of the defensive armor plate, and the tensile strength of its material, it is as easy to find out its resisting capacity. We can, therefore, predict what the shot is capable of doing, and what is necessary to stop it out."

This, then, is the vital question: "What is necessary to stop it out? To stop these masses of iron and steel, traveling at the rate of 1,200 or 1,500 feet per second?" It must be evident from the foregoing, that mere thickness of iron will not suffice, unless that thickness be something greater than that of any plates yet manufactured; and this

gun, with the light charge of 50 lbs., moved the shield bodily, 5 inches, broke several bolts, cracked and drove far to the rear, large portions of the rear supports, and, in short, made a general wreck of the target.

opens up a most important question, second only to that of resistance, namely, cost. Without going into figures at this stage of our inquiry, the following extracts, from a graphic description in the "London Times," of the rolling of a 15-inch plate will give some idea of the cost of these masses of iron, and the labor and danger attending their manufacture. The plate is 20 feet long, 4 feet wide, and weighs 21 tons:

"A great deal of the success depends upon the time at which the plate is drawn, and the amount and length of time to which it is to be heated. All this is regulated by the chief roller and chief furnaceman, who are paid wages which many professional men might envy—wages amounting from £1,200 to sometimes £2,000 a year. * * * The signal was then given, and the whole mass of iron, fizzing, sparkling, and shooting out jets of lambent flame, was, by the main force of chains, attached to the steam rollers, drawn forth from the furnace on to a long wrought iron car. The heat and light which it then diffused were almost unbearable in any part of the huge mill, but the men seemed to vie with each other to approach and detach the colossal pinchers which had drawn the iron forth. More than a dozen attempts were made on Friday, before this was effected, and more than a dozen of the best and most skillful workmen were driven back, one after another, by the tremendous heat and glare. At last all was made clear. The forceps, then red hot from their grip of the plate, were drawn away, the chains cleared from the rollers, and with a great hurrah the workmen seized the chains attached to the iron truck, and drew it to the incline by main force, where it was left by its own weight to run into the jaws of the rolling mill. It was then *sauve qui peut* among the workmen, who rushed for shelter in all directions as the mass was nipped between the rollers and wound rapidly in, amid quick reports, like those of dull musketry, as the melted iron was squeezed by the tremendous pressure out of the mass, and flew out in liquid jets on all sides. In spite of all the care and all the skill which the best workmen can use on these occasions, they cannot

always escape the splashes of melted iron, and the burns inflicted are numerous and often severe. The turning of the rollers crushes the plate through to the other side, where it rests for a minute on a wrought iron truck, similar to that on which it was brought from the furnace. The action of the rollers is then reversed after they have been, by the action of screw levers, brought closer together by about an inch. * * * The required dimensions were obtained, as we have said, by less than a quarter of an hour's rolling, and a plate 15 inches thick, the product of the labor of nearly 200 men, and of the consumption of nearly 250 tons of coal, was shot out by the rolling mills and left to cool."

But reverting again to the question suggested by the *dernier mot*, quoted from the "Standard," "what is necessary to stop it out?" another and the real question is suggested, namely: Out of what? The point or work to be protected once given, we have then a base of operations, a foundation on which to build, a data from which conclusions may be drawn. Supposing, then, the question to be the defences of New York and its harbor, we naturally turn to the existing works on which so much has been expended, and two questions again come to the front: Can these works be made effective? or, should new works be constructed? The first question supposes that these works are capable of being made the nucleus of a reliable permanent fort. The second, that they are useless, and really require to be defended instead of being a defence. A great part of the facts and arguments already noticed will apply to the construction of new works, which have for their object the stopping of the shot at the point of impact. So, for the present, we shall consider what can be made of the existing works. The fate of the English experimental granite

casemate will show that in their present condition these works are almost defenceless, and would soon be rendered altogether untenable if attacked by the more powerful classes of iron-clad ships. Two prominent attemps have been made, one in England and one in America, to protect stoneworks by iron plating, and with similar results. The English experiments referred to were the right and left wing facings of the granite casemate, which, in a word, proved failures. The results of the American experiments are reported as follows by the New York correspondent of a London daily paper:

"The target was composed of a solid wall of hewn granite, 30 feet in height, 36 feet in width, 7′ 9½″ in thickness through the main part; at each end, however, an additional wall 4 feet thick and 4 feet wide was attached—making the total thickness at the ends about 11 feet and 9 inches. The plates were four in number, of 4-inch rolled iron. Upon the upper half of the target these plates rested directly against the wall; upon the lower half, a backing of 6 inches of sand intervened between them and the granite. The plates were attached to the granite by bolts running through the wall, which was cemented and otherwise secured in tremendous clasps by heavy iron "dowels" or "toggles," or bolts and girders. The guns used were of the Rodman patent, and were two in number, one a heavy 12-inch rifled gun, the other a 15-inch smooth-bore. The guns were discharged at a distance of 350 yards from the target. The first shot was fired from the 15-inch Rodman; elevation of gun, 40′; weight of the charge of powder, 46 lbs.; the projectile, a round shot, weighing 432 lbs. The initial velocity of the shot was 1,155 feet per second. The ball struck the upper plate at a point near the centre, making an indentation of 3¼ inches in depth, and 15½ inches in diameter, a diameter only half an inch greater than that of the ball. The effect upon the wall was to crack two of the granite blocks at the back of the target, or nearly eight feet from the plate, and drive them from their bed of cement. The second shot was fired from the same gun. Elevation

of gun, 35′; charge of powder, 46 lbs.; weight of projectile, 432 lbs.; initial velocity of ball, 1,130 feet per second. The shot struck the lower plate of the target at a point 13 inches from the base; diameter of the indentation, 18 inches; depth, 5½ inches. The blow produced no serious effect upon the granite wall, three of the blocks being slightly moved or started, and no fractures being perceptible—facts undoubtedly due to the six inches of sand-backing with which this plate was protected."

After describing each round and its results, the writer goes on to say:

"The target was now reduced to a mere wreck, and the last shot was fired at the south end of the wall, which was not covered by the plates, but which had been strengthened by the addition of four feet of masonry at the rear. The smash-up was astonishing; blocks of granite at the rear of the target—or nearly 12 feet from the point of impingement—were wrenched from their fastenings and thrown upon the ground, and the wall was generally disturbed and cracked throughout. The experiments will be resumed as soon as a new target is built. The vulnerability of such a fortification is to be tested at different ranges. The guns have been trained upon the target thus far at a distance of only 350 yards. It should be remembered, however, that at that distance only 11 shots were necessary to ruin a wall nearly 8 feet in thickness at its thinnest part (and with abutments 12 feet in thickness), 30 feet in height and 36 feet in width, and protected, as to three-fourths of its surface, by plates of rolled iron 4 inches in thickness. Of course, if this had been a section of a real fort, and equipped with ordnance, all the guns would have been dismounted or rendered useless."

We come now to the second main division of our subject, that is, if the shot cannot be successfully resisted at the point of impact, can it be received and its power absorbed before it reaches the vital part of the structure? Several schemes for this purpose have been brought forward in Europe, especially in Eng-

land, and some of these are in the Paris Exhibition. The one which has attained the greatest notoriety, and which really seems to possess the greatest advantages, is that of Mr. CHALMERS, who furnished the best and most successful shield in the aforementioned granite casemate. In the case of this shield, however, Mr. CHALMERS contends that his ideas were not fully carried out; the engineer officers of the government insisted on certain changes, which destroyed the elasticity of the structure, and, along with the brittle nature of the iron, led to the snapping of the bolts already alluded to. The plan which he proposes for strengthening stoneworks, is somewhat similar to that adopted in the naval target which bears his name. Besides the original target and the granite casemate shield, Mr. CHALMERS has a target, tested this summer at Vincennes, which illustrated, in a marked degree, the value of the elastic principle embodied in his original target. This plan, however, which has attracted the attention of three of the European governments, has a more direct reference to the question under consideration. Plate X is an elevation of a shield or part of the wall of a fort. The plan consists, as seen on a larger scale in the vertical section (Plate XI), of a compound backing of timber and iron, supporting a series of ⊢ girders, faced by iron plating, as shown in the sectional plan (Plate XII). The cells C, between these girdes, to be filled with asphalt.

This plan was laid before the British Fortifications Department, at the request of one of its prominent engineer officers, about three years ago, and it has

evidently influenced some of the projects now being brought forward by that department. One of these designs is thus referred to by a London daily paper:

"Beyond this, the brick and granite walls are covered with 4½-inch plates, about 12 feet long, and 3 feet 6 inches wide, backed by 4 girders of angle-iron and ⊢ plates, concrete about 5 inches thick being run in between the plates and the girders."

This arrangement is almost identical with that shown in the sketch, but it is doubtful if it would give an equal resistance to the plan of the "CHALMERS target." The shield which this sketch represents may be adapted to iron-clad stone forts (for forts, like ships, must now be covered with iron) or to earthworks. In the latter case, the broken ends, shown at H H in the sectional plan (Plate XII), can be continued into the earthwork as far as may be considered necessary.

In addition to these papers and sketches, I have received from Mr. CHALMERS others, specially referring to the protection of stone forts by iron armor. The annexed cut (Plate XIII), shows the system adopted in the original CHALMERS target, applied to stoneworks, without any reference to the internal arrangements of the works themselves. The object of this distribution of the iron is to offer such resistance to the projectile, at the point of impact, by the plating, as will materially check its velocity, so that the remaining work it may contain will be used up in crushing the ribs and timber, before it reaches, or impinges with much force, on the inner plate D (Plates XIV, XV, XVI). For instance, the

300-pounder ARMSTRONG was fired at the CHALMERS target with a solid round shot, weighing 150 lbs., propelled by 50 lbs. of L. S. rifle powder. The striking velocity was 1,620 feet per second, and the work was 2,730 foot-tons. The shot crushed through the outer plate, $3\frac{3}{4}$ inches thick, and 10 inches into the compound backing, where it stopped without disturbing the inner skin. Had this target, therefore, been the facing of a stone fort, the work would have been effectually protected.

The structure represented in the sketch is, at least, 100 per cent stronger than the CHALMERS target, and would doubtless, protect stoneworks, such as those that defend the harbor of New York, from the attack of any naval gun in existence. Two years ago, this compound backing of timber and iron and the ⊢ girder arrangement were both referred by the French Minister of War to a commissioner of military engineers, and notwithstanding some objections arising out of the perishable nature of timber, the commissioner strongly recommended the above system for shields and other land-works, in preference to the ⊢ girder plan or any other that had come before them.

The sketch will illustrate the method proposed for fastening this armor to stone walls. Plate XIV is an elevation of a portion of the stone wall, Plate XV being a vertical section, and Plate XVI a sectional plan. The wall is first covered with the inner plating D, then the bolts B (Plate XVI), are let into the walls, and secured in the most approved manner; these should be of sufficient length to come through

the vertical binding-plates P (Plates XIV, XVI). By means of these bolts the backing is securely fastened to the stonework, and the plates are attached to the timbers of the backing by wood screws, such as those in general use in the French navy.

Thus the main or inner fastenings are protected from the direct blow of the projectile, and the outer fastenings being screwed into timber, will not snap under impact, like those which bind a rigid structure.

The value of the backing here described and illustrated, will be seen by reverting to the account of the first and second rounds fired at the Fortress Monroe target. The first was fired at the plate which rested against the stonework, and "the effect upon the wall was to crack two of the granite blocks at the back of the target—or nearly 8 feet from the plate—and drive them from their bed of cement." In the case of the second shot, "the blow produced no serious effect upon the granite wall, three of the blocks being slightly moved, or started, and no fractures being perceptible, facts undoubtedly due to the six inches of sand backing with which this plate was protected." There was, however, no lateral strength in this sand backing, hence it was not a suitable medium to distribute the force of the blow over a large surface of stonework, for it communicated the work in the projectiles directly to the stonework, in the rear of the point of impact. But such would not be the case with the compound backing, the inner ribs of which would in connection with the timber, distribute the effects of a blow, if at a low velocity, over a large surface, while shot fired at a high velocity, would crush the indi-

vidual rib or ribs, on which it impinged, one or two ribs not having sufficient strength to move or disturb the wall on which they rest. Were these ribs or stringers made of thicker plates, with a view to arrest the shot at the point of impact, they would be able to communicate the full energy of the blow to the stone-work in the rear, so as to destroy the cohesion of the entire structure. The penetration of a shot into a backing of this nature does not greatly injure the efficiency of the structure. The shot would generally stick unbroken in the backing, and its inertia would offer an effectual resistance to another shot striking on the same point.

One of the most important features of this backing is the facility with which any damage could be repaired. The plates of the "CHALMERS target" were twice removed and replaced; first after 31 rounds, and the second time after 45 rounds had been fired at it. The reason for this is in some measure accounted for in the reports of the iron plate committee, in which it is stated that—

"The experiment proved that this system of backing affords great support to the armor-plates, and prevents their distortion from buckling. It is also of considerable advantage in adding strength and resisting power to the structure. No other target designed for naval purposes has resisted a similar weight of shot with so little injury."

Coming to the question of cost, it will be evident that any estimate, in a report of this nature, can only indicate the probable cost by figures that may be affected by data which are continually changing, such as the prices of iron, labor, &c. But one point is quite

clear in regard to the system of protecting stone walls proposed by Mr. CHALMERS, and that is, no *expensive* iron or other expensive material is required; the plates may be, in respect of length and breadth, such as will be most economical in first cost, because plates of great length or breadth are not required to give strength to the structure, on this system. The weight of iron proposed per square foot, as represented in the foregoing sketches, is 320 lbs., or equal to 8 inches thickness of plate. This, at $60 per ton (of 2,000 lbs.) gives a cost of $960 per square of 100 superficial feet, and allowing over 50 per cent for cost of timber, bolts and labor (say $540), the square of 100 feet of this armor would cost $1,500. Hence, a height of 40 feet, by a length of 1,000 feet, could be covered for $600,000.

The chief argument in favor of an entirely new system of defensive works is, that turrets, placed at certain points, would cost less than to cover the entire face of the present works with iron armor. But there is no necessity for covering the whole of the present works, if a few turrets, mounting three or four guns each, suffice for the defence of New York. If, say a dozen guns be deemed sufficient defensive armament, then these, even of the largest calibre, can be more effectually protected in the present casemates for $50,000 or $60,000. If it be asked, "What then would become of the unprotected parts of the granite structure?" the reply is: "They would be in exactly the same position as as if the proposed system of turret defences were adopted."

If the above figures indicate, even approximately, the actual cost of covering granite walls with iron armor, they show that those grand and costly works, designed and erected to defend the harbor and city of New York, can, at a comparatively small cost, be maintained in all their efficiency—an efficiency which, considered offensively, is capable of sinking any iron-clad that might attempt to pass them. How different a fate to that to which they would be consigned by the building of new turreted structures, to protect and defend them. These new works, like all others, must have foundations laid for them, but the present lines of granite fortifications, bristling with guns, not only afford the foundation, but form the backbone of stronger and more reliable defences than any turreted structure mounting a few heavy cannon, and depending on mechanical contrivances for training and working them. Besides, the construction of works entirely new in their design, scope and armament, presupposes the present armament to be wholly useless, and regards as a national loss not only the forts themselves, but all their guns, with their carriages and fittings. The extent of this loss may be roughly estimated by the facts that the appropriations to the ordnance department of the United States, for the financial year of 1855–6, were upwards of $30,000,000, and that the armament of our fortifications includes 3,546 serviceable cannon, of which 1,334, or more than one-third, are of 8, 10, 15 and 20-inch bore. Now, what is the value of these guns, which such new works as those referred to would, in a great measure, render useless? That is, what is their value as offensive weapons, sup-

posing them to be mounted in their present casemates, and properly protected in the manner proposed by Mr. CHALMERS? The following extract from a report of certain experiments made at Pencote battery, over three years ago, will show that even our 10-inch guns are not to be despised, nor could any iron-clad pass with impunity within a thousand yards of a fort armed with these guns:

"The target fired at consisted of one of JOHN BROWN & Co's 5-inch plates, backed by 20 inches of solid oak, and placed against a bank of clay. The gun used was the 10-inch smooth bore. The charge was 40 lbs. HAZARD cannon powder, and the shot was of solid cast-steel, weighing 141 lbs. This shot struck 25 inches from right edge, 15 inches from top edge, and 13 inches from lower edge of target, pssing completely through plate and timber, and imbedding itself ten feet into the bank, where it was found unbroken."

Such are the armaments which an entirely new system of turreted works would render useless. True, heavier guns are demanded by the exigencies of modern warfare than those 10-inch cannon, but a few of these guns brought to bear on a single point, and fired simultaneously, would suffice to destroy any iron-clad in existence, while they would be more easily trained and less likely (all of them) to miss, than one heavier gun throwing a shot of 1,000 lbs. weight. The common estimate of the offensive powers of a ship of war has been the number of her guns, or her broadside weight of metal; and the same rule holds good in the case of fortifications, provided the several guns of any fort are not absurdly deficient in calibre. When the floating Warrior target (20 feet by 10) was anchored at

the distance of 1,000 yards, and fired at by 300-pounder and 600-pounder guns, although the distance was known to a yard, three rounds were fired before a hit was made, and four afterwards, without hitting the target. Several naval officers present were of opinion "that 50 or 60 ships, steaming at the rate of 10 knots, and yawing so as to alter the range, might pass such a battery without one of them being hit;" and such would doubtless be the case if the defence of New York was wholly dependent on a few monster cannon. Guns of the largest calibre are, doubtless, as necessarily a part of the armament of a first class fort as an artillery brigade is to an army; but no general would think of fighting a battle with artillery alone, neither would wise men trust the entire defence of a great city to a few pieces of monster cannon.

WAR MATERIAL.

BREECH-LOADING SMALL ARMS.

If the question of fortifications at the present juncture be the most important to the State and city of New York, that of breech-loading small arms is certainly receiving more attention from military men generally and from the great military powers of Europe. No other branch of the munitions of war appeared in greater force at the Exhibition, or attracted more attention, even from the general public. It is nevertheless evident that the majority of the arms exhibited are only crude conceptions, hurriedly executed. Indeed, a very cursory examination of their mechanism and principles of construction will show that the problem to be solved—a very difficult one—has been but imperfectly understood by their inventors.

Before, however, proceeding to notice or describe any of the guns on exhibition, it may be well briefly to consider the nature of this problem. As this has been done so often from an American point of view, perhaps it would better advance the interests of the American people if I were on this occasion to lay before them some European view of the question. Taking the "Scientific Review" as a fair exponent

of this question as understood in England, the problem is thus stated. It is required to project a body, whose shape and weight are not yet absolutely defined, with the lowest trajectory or path of flight, and the greatest possible accuracy to the farthest attainable distance, and that all this should be done with the greatest rapidity. Flatness or lowness of trajectory comes first; for, though a projectile should be sent with absolute accuracy to any desired distance, yet if it could not pass through several objects on the same level, at distances up to 500 yards, it would be deficient in one of the principal qualifications of an infantry arm. Then comes accuracy; for without this, mere range would be of no value whatever. Rapidity is the next important element, for thus the disposable force in the field has its efficiency trebled or quadrupled at important moments; and last of all comes long range, the grand desideratum of target practitioners, when combined with the two first elements spoken of, but deservedly held in comparative contempt by military men, who know how seldom distant shooting contributes to the winning of a battle.

But it will be observed that so long as the shape and weight of the body to be projected has not been defined, it is absolutely in vain to seek the solution of our problem. Even if it be found that a certain shaped bullet of lead, of a certain weight—for instance, a WHITWORTH hexagonal projectile, .442 diameter, 532 grains, 2½ diameters long—is one which gives on the whole the greatest measure of the above-named qualities, this will be of no value so long as it is not

known whether such a bullet will fullfil the other numerous conditions which are essential military requirements. Can it be applied in a breech-loader consistent with rapidity of fire? Can it break a horse's leg at considerable distances? Does it necessitate great length of cartridge? These, and many other questions, must be satisfactorily answered before it can be confidently predicted that such a projectile is the one for which we are to make a breech-loading rifle and cartridge. Then, again, by an admixture of different substances in the bullet, we may derive various advantages in some directions; generally, however, accompanied by corresponding defects in others. Thus, if the bullet be on the METFORD principle, we shall get increased accuracy; but the trajectory will be higher, by reason of the diminished specific gravity. If we follow the Prussian principle, where a solid of least resistance is the shape of the bullet, while a sabot, not the lead, takes the grooving of the rifle, we shall get increased velocity but diminished weight, a flatter trajectory but less penetration. On every account, therefore, is it necessary that we should first know what we have to throw before we set to work to find out how to throw it.

The considerations which must influence us in deciding on the weight of bullet we should employ, are principally those which have relation to the power of the soldier to support his necessary load when fully equipped for a campaign. Now, if we take each bullet as weighing one ounce, or 437.5 grains, as there are 7,000 grains in a pound avoirdupois, this will give him, irrespective of cartridge case or powder, 16

bullets to the pound. From 6 to 8 lbs. are as much as any military man will allow could be devoted to cartridges out of a man's total equipment. Let us take the less weight as the more desirable one, and we find that with only an ounce bullet, instead of 480 grains, which is the weight of the last pattern BOXER ammunition, he would have 96 bullets in his pouch. But, besides this, there are 70 grains of powder to each ball, and a cartridge case, whose weight will not be less than 100 grains, to contain it and the fulminate. This raises the weight of each complete cartridge to 607 grains, and now his 6 lb. weight will give him only 69 cartridges, which is but 7 minutes supply for an arm capable of firing 10 shots per minute. It is perfectly true that these 7 minutes may decide the fate of a general action, and that some system of ammunition supply in the field can be, and must be, organized to supplement the deficiency in weight-carrying power of the individual soldier; but there are many situations in which troops are required to be thoroughly efficient, and where such supplies may have been, for the time, left behind. This will always make it desirable that great attention should be given, and that some sacrifices should be made, in order to the soldier's carrying the greatest number possible of cartridges. Considerable advance can here be gained by the suppression of the unnecessary and clumsy pouch—unnecessary with water-proof cartridges, and clumsily placed for rapidity of fire with a breech-loader.

It will be easily understood that those who profess to give 60 cartridges, with a weight of only 4 or 5 lbs.,

must have sacrificed the weight of the bullet to a far greater extent than has hitherto been thought advisable; for even the bullets are far below the military standard, and 60 of such, with 70 grains of powder, would weigh over 5 lbs., if we include the necessary cartridge case, at 100 grains each. Even if the cartridge be made up as formerly, of common paper, the economy of weight will not be more than 4,000 grains on the 60 rounds, and great sacrifices of durability, efficiency, etc., etc., would have to be submitted to. But that part of the question has, we may assume, been definitely settled in favor of some form of metallic case. Therefore, the weight of bullet we should arrive at might vary between 1 ounce, 437.5 grains, and 480 grains, the weight adopted by the French government, as well as latterly in the BOXER cartridge. But it has been said that less than 530 grains, the weight of the old ENFIELD bullet, will not suffice against cavalry. If this be true, it would be a strong, though not a fatal, objection to a lighter bullet. It is a point on which experiment ought to be made.

The next part of the subject will naturally be the shape of the projectile; and here any variation will produce most important effects. The experiments of Mr. WHITWORTH and others have satisfactorily established the fact that $2\frac{1}{2}$ diameters for the length is the proportion which gives the best mean results in shooting, with a given twist in rifling; but unless we go so low in calibre as .442 we shall not get a leaden bullet of such proportions within the weight of 480 grains. With clay and wood, indeed, as dis-

posed in the METFORD, or in any way taking a central position in the length of a bullet, we can get almost any proportion that is desired; but we sacrifice inevitably penetration, range and trajectory to obtain accuracy, and this is gained only on calm days, for the less the specific gravity of the mass the more will it be affected by a disturbed atmosphere. Taking all these things into consideration, it is evident that the very first series of experiments that a scientific committee might wisely make, would be those having reference to the effects of certain bullets out of whatever gun, and that not till the bullet question had been set at rest, would there be any probability of a successful issue to a search for the best rifle. For, not till we know what the machine has to do, can we possibly tell which machine will do it best. The rifle is nothing more than a machine, or engine for throwing bullets or projectiles; the question primarily seeking solution, therefore, is and must be—what projectile?

Let us, however, imagine the question solved. We are to have a half-inch calibre—500 of an inch instead of 577, the Enfield, or, 442, the small bore. Our bullet is to be $2\frac{1}{2}$ diameters long, by having a hollow base, and 480 grains weight. The next question will be as to the propelling force—the explosive agent. Shall we stick to gunpowder or try gun-cotton? Is there any other agent as little dangerous, as cheaply producible, as thoroughly reliable as gunpowder, but which will give us no smoke, will occupy less space, and will economize our weight? Which of the xyloidines is to be preferred, and shall

we not try experiments upon them? For we cannot settle the cartridge question till we know what powder as well as what ball; and, curiously enough, the rifle, which has been taken first, is precisely the last question the solution of which is to be undertaken if we go scientifically to work. If no other substance than gunpowder is to be used, yet it may possibly be made to occupy less space by compression, and the cartridge may then be smaller. It is even possible to do away with the cartridge altogether, and fill the cavity in a more or less hollow bullet with the explosive compound. But any such changes as those here indicated would at once upset the existing forms of breech-loader; and we have a new proof of the necessity for defining the charge before we begin to decide on the arm from which it is to be fired.

With regard to the shooting obtainable by a military rifle, it must be recollected that a slight difference in the bullet used has made the shooting of the navy Enfield nearly fifty per cent worse than it had been before; so that as soon as the bullet is chosen, the powder selected, and a proper cartridge case has been devised, it will be needful to consider the best form of grooving (which may be very different with a breech-loader), the best twist and the right length of barrel. We have had numberless reports, but these important points remain as unsettled as ever. We do not know what size or weight our barrels may be when made of steel; we have never considered why or whether it was necessary to carry four or five pounds weight of wood in

a stock; and it is certain that the present lock, handed down from the days of flints and matches, is not the most simple method available for igniting a percussion cap.

In breech-loaders which, like the SNIDER, are closed by a solid breech-piece, it is only necessary to see that this is securely locked in firing; and it is hard to see why it has not been done by those, who adopting the MONT STORM shoe, might likewise easily have taken the MONT STORM bolt. In others where, as in the JOSLYN and CORNISH, a shorter breech-piece, unsupported in rear, is adopted, it will be of the utmost importance, not only that they should be securely locked in firing, but also that the cross section of the slot which holds the breech-piece against the force of the discharge be at least equal to that of the screw thread of a breech-plug in an old muzzle loader. The principle of the HENRY and SOPER rifles, being exactly that of the wedge breech-loading cannon, can be trusted implicitly as to strength, but are unsightly from the large breech required, and the hammer hitherto has been the reverse of well arranged or shaped. The bolt principle, first embodied in the Prussian needle-gun, and modified since as in the BURTON and others, though it secures some advantages, having only four motions in charging and discharging, no outside hammer, and a general look of effectiveness, yet fails in several most important points. It will always be dangerous to force home a loaded cartridge by a sudden blow or push from behind; the long sliding surface will wear and jam if sand

get into it; it is anything but simple, and spring extractors as well as spiral main springs are to be avoided if possible. It is not an easy task to say what the future arm will be, but it is not difficult to predict that it has not yet been brought forward.

Such are the views that prevail in Europe on this question, and these are entertained chiefly by scientific men and amateur gunmakers, rather than by those who have the power to follow them up to their legitimate conclusions. The guns which attracted most attention at the Exhibition, such as the Needle-gun, the Chassepot, and the Snider, have not reached the point which they have attained by following the scientific path now so skillfully defined, but are rather the result of circumstances which existed before they were thought of and which influenced their mechanism to an extent but little appreciated by casual observers. If this be only partially true of the Needle-gun, it is especially true of the Snider. In this gun, as used in the British army, some of the more important points in a military weapon have been considerably reduced in value by its conversion to a breech-loader. The trajectory is much higher than with the Enfield, and the accuracy is generally allowed to be fifty per cent worse. It is true the accuracy has of late been improved by the use of a different bullet, which fact tends to corroborate the views previously laid down. But by the side of this increased accuracy there is a serious evil which General Hay (Inspector-General of Musketry) immediately noticed, of a higher trajectory and lessened penetration. According to the rifle committee's

report, whereas the trajectory of the Enfield rifle before conversion, with a leaden bullet and wood plug was at 500 yards 1°23′, after conversion it was 1°25′. At 800 yards it had been 2°28′, after conversion 2°38′. Again, whereas the Enfield rifle at 30 yards used to penetrate $12\frac{1}{2}$ half-inch elm planks placed in a frame half an inch apart, after being soaked in water for two days, SNIDER's converted Enfield pierces $10\frac{1}{4}$ only with the 525 grain bullet; and since the introduction of a lighter bullet (480) grains of a less specific gravity, owing to its having the METFORD arrangement of wood plug in front as well as clay plug in rear, the penetration seems to have sunk to 11 pine planks of similar thickness to the elm, but which offer far less resistance. General HAY finds that at 600 yards the elevation of the SNIDER is really 1°58′, against 1°45′ of the ENFIELD, or no less than 22 minutes of a degree more. This with the amended bullet of 480 grains. With the bullet used before General HAY found the shooting of the SNIDER, as he says, "wretchedly bad," the figures being, at 600 yards, elevation 2°16′, instead of 1°45′ as above, for the muzzle-loader, and deviation 4.01 feet, instead of 1.58 feet. Can there be a more convincing proof that the projectile ought to have been first studied?

The bullet of the Prussian Needle-gun is, in respect of the conditions hereinbefore enumerated, perhaps the best devised. As an introduction to the gun itself a few words about the bullet and cartridge will not be without interest. Plate XVII, fig. 1, is an illustration (full size) of the four parts, the bullet, the carrier-wad, the cap, and the charge of powder, of

which the cartridge is composed. The carrier-wad W, is formed of strips of paper, moulded into the proper shape by heavy pressure, and its uses are as follows: It holds the cap C, containing the fulminating compound, protecting it from chemical influence or other injury; it receives the first impulse of the explosion and transmits it to the bullet, thereby economizing the force of the powder; it is compressed into the grooves of the rifling, and thus imparts a rotary motion to the bullet, which does not itself touch the barrel, and hence the grooves never get clogged with lead; finally, it cleanses the barrel at every discharge of the gun. The wad accompanies the bullet through some 50 or 60 yards of its flight, and about 20 yards from the gun it strikes a target about three or four inches below the bullet mark, and at this distance will pierce a pine board of over half an inch in thickness, so that at short range the gun may be said to carry two projectiles. The ignition of the powder from the front is, however, the great feature in the needle-gun, as by this means the powder is all consumed and rendered effective.

Coming to the *Zundnadelgewehr*, or Needle-gun, itself, we are less struck by the novel features of its construction than by its almost romantic history and its recent performances. Without, however, entering upon its history, a subject foreign to the objects of this report, or discussing battles and victories of so recent a date, I shall merely allude to the almost prophetic royal decree referring to its adoption in the Prussian service, which says:

"The rifled Needle-gun is, according to our present conviction, the perfection of military arms, and its practical introduction will no doubt lead to its adoption in all branches of the service. The result of numerous experiments made us appreciate this invention as a special dispensation of Providence for the strengthening of our national resources, and we cherish the hope that the system may be kept secret until the great part which it is destined to play in history may couple it with the glory of Prussian arms and the extension of empire."

The fundamental principle of the Needle-gun, as already stated, lies in this, that a cartridge is employed, which contains within itself the fulminating compound that is to ignite the powder, and since this fulminate lies buried between the powder and the bullet, it can only be reached and struck, and hence ignited, by a needle piercing the cartridge. The principal features of the mechanism are as follows: First (beginning with the feature most notorious), the needle, fixed in a holder or bolt encircled by a spiral spring, the recoil of which is to dart the needle into the explosive charge; second, the lock, or appliance for drawing the needle back to put it in connection with the trigger; third, the chamber, which forms the breech-piece, and which carries a little tube or guide through which the needle passes to the cartridge. The whole of this mechanism is carried in a cylindrical case which is fixed to the stock by bands, and into which the barrel is screwed, so that the case forms, as it were, a prolongation of the barrel; lastly, there is the trigger, which when pulled, discharges the needle from its detaining catch. How these various parts are disposed, and what is their action, will be under-

stood by the accompanying diagram and description. The illustration (Plate XVIII), shows the position of the parts at the moment of firing, just as the needle has struck the fulminate. A is the needle-bolt carrying the needle and furnished with two shoulders or projections *á* and *a*, the hinder part passing through a spiral spring. B B is the lock for drawing the needle-bolt back; it is in the form of a little tube with a projecting thumb-piece at one end, and a little tooth or catch (catching the projection *á* of the needle-bolt) at the other; it is, moreover, held in its place by the locking spring *b*, but can be drawn back when *b* is pressed down. C C is the chamber, also tubular, in which is fixed the needle-guide *d*. This chamber slides backwards and forwards in the outer case by an action precisely similar to a street-door bolt, and it is furnished on the outside with a knob or handle by which to move it, bolt fashion, a slot (not shown in the sectional drawing) being cut lengthwise in it to allow it to pass the catch *h*. Its beveled or conical end exactly fits the corresponding beveled or conical end of the barrel, and it is forced into close contact with the latter by a sidewise motion of the knob (bolt fashion again), which motion by thrusting the base of the knob *c* against the slightly inclined edge *f* of a slot in the outer case, jams the two beveled surfaces together, and thus tightly closes the breech. D is the trigger upon the spring *g*, and this upon the catch *h*. It will be seen that the upper surface of the trigger's horizontal arm takes its purchase against the under side of the case, and that it is fur-

nished with three knuckles or points of pressure; and it will be easily understood that according as either of these are pressed against the case (by pull upon the trigger) so will the catch *h* be drawn down to a greater distance. The first one is in bearing when the gun is out of use, or immediately after firing; when the second or middle one is brought to bear, the catch *h* is drawn down sufficiently to allow the needle-bolt shoulder *a* to pass over it; when the third is brought to bear, *h* is so far withdrawn that the whole of the lock-tube B B will pass over it, so that a soldier can if necessary disable his gun in a moment. If he has to retreat, leaving his gun behind him, he merely pulls the trigger very hard, and draws B B out by the thumb-piece, and he leaves behind him an empty useless barrel.

These various parts are thus manipulated in the process of loading and firing:

First, the thumb is pressed upon the spring *b*, and by means of the thumb-piece the small lock-tube is drawn back, pulling with it, by means of the little tooth at the opposite end, the needle-bolt till the shoulder *a* is caught behind the trigger catch *h*. Then by pulling the knob a little on one side, and at the same time pushing it towards the butt end of the stock, the chamber C C with the needle-guide is slid back and a clear space is left in that part of the case which is in our drawing occupied by the needle-guide. Through the opening thus made the cartridge is inserted into the end of the barrel, as shown by the dotted lines in diagram. The chamber is then bolted up againand the thumb-piece, and so the lock-tube, is

pushed forward to its original position. The position of things is then just as shown, with the exception that the needle-bolt, and with it the needle, is held back by the shoulder *a* catching against the trigger detent *h*, the spiral spring being of course compressed or in tension. The gun is then ready for firing, the trigger is pulled, *h* is drawn down, and the spring released darts the needle through the guide into the cartridge, the blunted end of the needle sharply striking the fulminate and thus igniting the charge.

The barrel of the gun is, in the latest pattern, 32 inches long and 0.6 inch bore, the breech end being widened out to admit the cartridge easily, and it is rifled with four grooves .03 inch deep, the rifling taking one turn in $28\frac{1}{3}$ inches. The total weight of the gun, without the sword-bayonet, is $10\frac{3}{4}$ lbs.

The advantages claimed for the Needle-gun are chiefly these: That the bullet is propelled through rifled grooves without violent forcing into the barrel —indeed without coming into contact with it; that the loading is simple and rapid, the ball, powder and cap being contained in the cartridge; that the loading is from the breech; that the combustion of the powder and cartridge case is more complete than in any other gun; that the escaping gas carries but little smoke with it; and finally, that the gun is instantly disabled if necessary. Some of these advantages are of course common to most breech-loaders; but there is one especial merit in the Needle-gun that is not so common to other constructions, and that is the ease with which the mechanism is made and put together. Concerning the durability of the gun, it is said that

many of the battalions of Prussian fusileers are using now the very guns served out in 1848.

Such are the advantages claimed for the Needle-gun by its advocates, but these and the decided victories in which it took a prominent part have hitherto failed to induce any of the European governments to adopt it. It is almost the only gun which has been used extensively which depends on the mechanical fit of its breech parts to prevent the escape of gas—a method of accomplishing this end which the majority of gunmakers endeavor to avoid. Indeed very few guns have followed the Prussian arm, even in the apparently advantageous feature of the sliding-bolt. The Chassepot is the only gun of note that approaches the Needle-gun in principle, but the method of closing the breech is at once different, novel, and ingenious.

The Chassepot, like the Needle-gun, is a cartridge-consuming weapon, and thus it avoids what in many breech-loaders is often a source of annoyance and danger, namely, the extraction of the empty cartridge case. The method of closing the breech is the chief distinctive feature in this weapon. In its general arrangement for this and for igniting the fulminate it bears a close resemblance to the Prussian gun. The breech-closing mechanism is simple, and is said to be effective; the point about which there seems to be most doubt being its durability. The closing of the breech is obtained by the compression, under the action of the explosion, of a vulcanized caoutchouc washer placed between the front end of the breech-bolt and a flange or shoulder upon the movable needle-guide.

The washer and the flange are a trifle less in diameter than the end of the barrel in which they act, so as to facilitate their play therein, but the diameter of the front face of the breech-bolt is as nearly as possible equal to the inner diameter of the breech. When the explosion takes place, the pressure transmitted by the movable needle-guide to the washer, compresses the latter sufficiently to hermetically close the breech and thereby prevent all gas escape. After the charge is fired and the pressure in consequence removed, the washer, by virtue of its elasticity, returns to its normal state. The washer is composed of three thicknesses, the middle one being of softer material than the two outer layers, so that on being pressed, the intermediate layer, which is perfectly elastic, expands and fills the breech. The mechanism of the breech consists of seven distinct parts.

The cartridge used in the Chassepot rifle, as described in the specification, consists of six parts, namely—the powder, the powder-case, the priming, the pasteboard wad, the ball-case, and the ball. The powder-case is formed from a rectangular piece of paper rolled upon a mandril and pasted at the edges. When the case is dry the priming is inserted by a mandril and the end of the case is then closed and pasted. The priming is composed of a copper cap like the ordinary military percussion cap, but somewhat smaller. Two holes are pierced in the bottom to allow free passage for the spark to the powder; the fulminating powder being placed at the bottom of the cap, a small piece of cloth or wax is placed over it to protect it from external concussion or

atmospheric influence. The cap is covered with a thin washer of brass or other suitable metal, which is pasted upon paper for forming the base of the cartridge. The priming is then complete. After the powder-case has been prepared as described, the charge of powder is inserted and pressed somewhat firmly to give the necessary rigidity to the cartridge. This compression of the powder in the case is by many considered equivalent to loss of power and consequent diminution of range, but this is a question open to debate, and practical results do not justify the acceptance of the hypothesis. A pasteboard wad is placed on the powder, formed with a hole into which the twisted end of the paper case is inserted, the excess paper being cut off. The ball-case is composed of a paper jacket having two folds of paper pasted and closed at one end only. The ball is of an elongated tapered form, with a flange at the base. After placing the ball in its case, a piece of string passed around a groove on the bullet a slight distance from the base firmly secures it to the cartridge case, after which the cartridge is greased and ready for use.

The SNIDER breech-loader has a different arrangement from either the Chassepot or the Needle-gun for preventing the escape of gas. Or, more correctly speaking, it has no arrangement at all for this purpose. Like the great majority of new breech-loaders it makes the cartridge the breech-closer, and hence the efficiency of the weapon depends fully as much on the cartridge as on the mechanism of the gun. The BOXER cartridge used in the SNIDER nominally consists of four parts—the shell, the cap, the powder, and

the bullet—but some of these are composed of several pieces, so that the Boxer cartridge consists of no less than fourteen parts, and the weight of the cartridge-case alone (which consists of two different kinds of metal) is about 200 grains. This cartridge, after undergoing many changes, seems to have finally settled itself into the shape and proportions illustrated and described as follows:

It now consists of the iron base *a* and the brass shell *b*, as shown in the wood-cut (Plate XVII, fig. 2). As the brass shell is not soldered to the iron base, a pasteboard wad surrounds the cap and fits to the bottom to prevent the escape of gas, and between the powder and bullet there is another wad of cotton-wool *c*. In the centre of the base-piece is fixed a cap of copper which contains the means of igniting the charge and from which the cartridge derives its name—central fire. For the purpose of retaining in the new projectile (although decreased in weight 50 grains) the length and figure of the old Enfield bullet, as also with a view to place the greater weight as far as possible from the centre of rotation, the bullet has a picket of wood *e* running through its centre half way from the apex of the cone towards the base. At the base is a cavity containing an expanding plug of baked earth *d*, which latter is also intended as a support to the sides after expansion. As was a necessity with the old muzzle-loaders, the bullet for the present breech-loading arm is still made smaller than the bore and depends for expansion into the grooves on the plug of baked clay at the base. The cartridge is covered with a paper covering attached by gum to

protect it from damp. The charge of powder is 75 grains, and the weight of sixty rounds is about 6 lbs. 10 oz.

The SNIDER rifle, in that it depends on the cartridge to close the breech, is to a greater extent than the French or Prussian weapon, a representative gun, and hence it figured more conspicuously at the Exhibition. Besides the grand display of the British government, the SNIDER Company, WHITWORTH, REILLY, and several other British and other gunmakers had samples of the SNIDER on exhibition.

The chief feature of the gun is the breech-block—a short cylinder nearly the length of the cartridge—which fits into a recess in the rear end of the chamber, and which, by turning up or down upon a hinge on the side of the barrel, opens or closes this recess for the insertion or the extraction of the cartridge. When closed, this breech-cylinder abuts at its rear end against the breech proper of the gun, and at its front end it covers the base of the cartridge. The wood-cut (Plate XIX) will sufficiently explain the nature of the breech-block, or cylinder. It represents a portion of the rifle, showing the end of the barrel D and the breech-block H. Here the breech is shown full open, and at this point the thumb on the thumb-piece S having turned the breech-block to the right hand, the block, hinged on the pin N by the socket B, is drawn smartly back, when the draw cartridge ejects the empty cartridge-case. According to the "Platoon exercise for long and short breech-loading SNIDER rifle," to load the SNIDER two movements are necessary, one of which is com-

pound, having several motions under the head of one order, namely, that part of the movement detailed at "three" of the order "present," and commencing, "Half-cock, open the breech and holding the breech-block firmly with the fore-finger and thumb, by means of the thumb-piece and the nipple lump; draw it back as far as possible by a jerk, raising the muzzle of the rifle slightly in so doing, to remove the empty cartridge-case, at the same time cant the rifle sharply over to the right to allow the case to fall out, bringing it again to the horizontal position; then carry the right hand to the pouch and take hold of a cartridge at the rim with the fore-finger and thumb." The cartridge is made so as to slide into the breech without pressing and with as much play at the rim as to allow the breech-block to shut freely. This is absolutely necessary, as the breech-block has no means of clearing a passage for itself in the event of the cartridge being too tight or its rim too thick.

Much has been said for and against the Snider-Enfield, which, after all, is only a converted weapon. As I have elsewhere alluded to comparisons made as to the shooting of the converted and unconverted gun, it may be nothing more than fair to quote the following paragraph from the "Times" of July 19, 1867:

"At the Wimbledon meeting this year a volunteer named Andrews belonging to a Kent corps, and firing with a Snider-Enfield breech-loader at the 500 yards' range, succeeded in firing off no less than 50 shots in the prescribed five minutes—that is to say, exactly 10 a minute. The shots, moreover, instead of being fired off wildly,

were delivered with steady aim. In the 50 shots he made 46 hits, of which 10 were bull's-eyes, 20 centres, and 15 outers, equivalent in all to a score of 133. At the very same range not four hours previously, a competitor had been cheered for making 97, which was then by far the highest score. The astonishing success which had thus been obtained with the government weapon became known very speedily all over the camp, and the council were actually pressed to confer upon Sergeant ANDREWS some special mark of recognition. His score, however, was eclipsed by the very last shots fired at the 200 yards' stage of the same competition. In the space of three minutes allowed at this range, a volunteer named OSWALD fired 38 shots, or at the rate of nearly 13 a minute, of which 37 were hits. His score consisted of 6 bull's-eyes, 20 centres and 11 outers—total 106."

Whether such excellent practice as the above is to be the rule or the exception with the SNIDER, time alone can tell. The accuracy in this case is no doubt due in a great measure to the marksman's superior shooting. Though this and similar testimonials may serve to justify the conversion of the ENFIELDS into SNIDERS, the British government do not seem to be in a hurry to adopt the principle for new weapons. A writer in the "Scientific Review" referring to the defects of the SNIDER says:

"There is a certain amount of consolation in knowing that if we have not yet worked out the question of breech-loading arms, our neighbors are no better off than ourselves. The French are far from satisfied with the Chassepot, and the Prussians are just becoming alive to the fact that even HERR DREYSE may be wiser than some others, but cannot be wiser than all others who ever made breech-loaders their study."

Other European nations are equally at sea on this great and absorbing topic. Nor do the hundreds of breech-loaders exhibited on the Champ de Mars give

any indication that the question is on the eve of being settled. The several competitions which have taken place in Europe have brought nothing superior to our own well known breech-loaders, such as the Roberts, the Remington, the Peabody, or such new weapons as the Broughton and others that might be mentioned. One of the leading gunmakers of England frankly admitted "that in the matter of small arms the Americans are in advance of the Europeans," and the results of two of the most important rifle competitions on this side of the Atlantic, corroborate this opinion. Indeed at the Vienna competition trials, the contest was virtually between the American guns—the Remington and Peabody.

To describe in the briefest manner, or merely to enumerate the breech-loaders in the Exhibition, is not the object of this report. It was only intended to give some idea of the prevailing notions on this question in Europe, and select a few prominent examples of the manner in which these principles are being—or rather are not being—carried out. With the exception of the weight of the bullet and the charge, which with us is considerably less than in Europe, the American breech-loaders are admitted, even by foreigners, to be superior in every other respect to the same class of European weapons. The weight of the general run of our bullets is from 300 to 450 grs., and of the charge of powder from 40 to 50 grs. The Peabody, Hammond, and one or two others use charges of 55 or 60 grs., but the charge of the Snider is 75 grs., and that of the Needle-gun 76, while the bullets of both are an ounce each. These

facts tell on the trajectory, the range, and work of the projectile, and if the comparison be against us in this case, it is consoling to know that the defects are easily remedied. We seem in this matter to have reversed our traditional policy in regard to ordnance, which has always been to excel our rivals in calibre and weight of metal.*

The Exhibition held a very limited display of magazine arms, but these, with one exception (Messrs. JARRE & Co., of Paris), were all American. The SPENCER and the BALL & RANSOM, are too well known in America to require to be described here, even if such had been the object in view. But these arms which have been highly commended by European officers and military critics, do not seem to take in Europe. Doubtless the expense has something to do with this, both in regard to the first cost of the weapon and the tendency of soldiers (such as make up the European armies) to waste their ammunition. In the hands of educated citizen soldiers the case is entirely different. On this subject an English critic says:

"I have often heard repeating arms objected to on the score that the supply in the magazine would be wasted by the soldier. When looking back at the register of the practice, to use a musketry term, on human targets of troops, but partially disciplined, that were armed with this description of weapon, during the late civil war in America, we cannot help looking on this objection as premature. Experience proves that in the only war where these arms have been tested, the great superiority and advantage the soldier had over the

* U. S. regulation cartridge for breech-loading muskets—centre-primed, calibre 50—has a charge of 70 grs. powder; bullet, 450 grs.

enemy, arose from the fact that his having such a weapon in his hand gave him confidence and self-possession, so that the chance of waste ammunition through excitement was actually diminished."

The weightiest argument against these magazine guns is doubtless the lightness of their ammunition. The powder charge of the SPENCER (a seven-shot repeater) is 45 grs., and the bullet is 400 grs. The BALL & RAMSON'S ammunition (a fifteen-shot repeater), is only 45 grs. and 350 grs. lead; while the HENRY (also a fifteen-shot repeater) is only 25 grs., and 216 grs. respectively. Capt. O'HEA—an officer who has given much attention to this subject—speaking of these fifteen-shooters says:

"He did not pretend they were effective at long range. He supposed that troops in line would travel 75 paces in half a minute at double-quick, that would be 36 inches per pace. That was going an extreme distance for a charge. During the time the men were charging they could not fire, nor could they have skirmishers in front to cover them, so that the line which was receiving the charge would have plenty of time to deliver 15 rounds with good aim with these rifles; and if one round in 15, or even 30, took effect, there would only be left half the number of men who commenced the charge. That was speaking of these weapons at short range."

Among the greatest novelties in the Exhibition, is an electric gun that carries the battery in the hollow stock. It is a French invention—Monsieur BARRON—and is yet only in its incipient stages. Whether it contains the germ of a principle that will eventually do away with dangerous fulminates, locks, hammers and anvils, will require some time and many experiments to determine.

A Mr. JONES, of Cheltenham, England, has succeeded in overcoming a difficulty connected with shooting at long ranges. The difficulty consisted in the awkward position in which the gun was held while firing at a great elevation—the stretching of the neck and straining of the eye to the elevated sight, and at the same time to keep the stock comfortably to the shoulder. Mr. JONES obviates these evils—which disturb the aim of the marksman—by a very simple contrivance. The stock of his gun is movable, or rather, one-half of it is. It has a hinge close to the trigger guard, and by means of a screw the lower half of the stock, carrying with it the butt that bears on the shoulder, is lowered or raised at pleasure to suit the elevation required. The accompanying wood-cut (Plate XX, fig. 1), will give an idea of the nature of this invention. The weapons to which the improvement was applied in the Exhibition, were sporting and not military arms. The difficulty experienced by the inventor at rifle matches in England induced him to try and conquer the inconvenience arising from elevating the ordinary gun to fire at ranges of from 1,000 to 2,000 yards, and though the arrangement devised was not intended for military purposes, there can be little doubt that for sharpshooters and advanced picquets it possesses considerable value.

The question of breech-loading firearms is at the present moment in a very bewildering position. The impetus given to it by our own war, and the late war between Prussia and Austria, has brought a thousand ideas to the surface, many of which are but

crude and half digested schemes, and the guns in which they were represented at the Exhibition were, in too many instances, so badly manufactured that they did not improve the ideas embodied in them. On this account, and excepting always such well known arms as I have already mentioned, I have confined my observations more to principles than to particular weapons, and have selected for illustration such only as would best illustrate the salient points of the question, or rather, those points which have come more prominently into view. Thus the Needle-gun illustrates the idea of igniting the charge in front and consuming the cartridge in the gun, as well as the plan by which the breech is closed by close fitting metallic surfaces. The Chassepot—another cartridge consuming weapon—shows a different method of igniting the cartridge and closing the breech; while the SNIDER is selected as the representative—not that I consider it the best—of those central fire breech-loaders which depend on their cartridge to prevent the escape of gas. I have only to add that I consider the collection of American small arms at the Paris Exhibition, including COLT'S and other revolvers, as highly creditable to our country.

ACCOUTREMENTS.

Closely connected with the question of improved breech-loading small arms, is that of the soldier's knapsack or kit-bag. The rapidity of fire in the case

of ordinary breech-loaders, and especially in that of magazine arms, will necessitate the carrying of a greater number of rounds of ammunition than heretofore. The old fashioned knapsack, in itself a heavy load, is enough to wear out the soldier on the march without the additional weight of ammunition. Why this antique and uncomfortable arrangement has been preserved so long, in an age alive with new inventions and improvements, is a puzzle to both soldiers and civilians. The British war authorities have long been considering the possibility of doing away with the knapsack. The Dean of Canterbury, in an advice to tourists, respecting the case which is to hold their "little all," says: "Let it not be a knapsack. A knapsack (*experto crede*) is a plague. Its *posé* when on is thoroughly uncomfortable, and there is the immense disadvantage that there is no changing its position. The inevitable two straps always chafe the same spots on the shoulder." The Dean concludes his remarks as follows: "Knapsacks are very good for soldiers, but very bad for tourists." On this point, however, the soldier holds quite a different opinion. The British War Office committee regard the knapsack as very injurious to the health and efficiency of the soldier. They allude in their report to the experience acquired in recent campaigns in our own and other countries, and finally recommend the adoption of a kit-bag in lieu of the old knapsack. Alluding to this change, the "Lancet" observes:

"The third report of the War Office committee appointed some three years ago, to investigate the effect of the present system of equipments on the health of the infantry soldier, has just been pre-

sented. We congratulate Gen. Eyre, president of the committee, on the successful termination of his labors. The opinion expressed of the equipment is most favorable, and it is clear that the objects aimed at by the committee have been attained. Pressure on the lungs and heart has been entirely obviated, and the weights press on no part which can be injured. The plan tried in the summer has been altered in various details in accordance with suggestions made, the committee state, 'by all ranks of the army.' We are informed that the private soldiers took immense interest in the trials, which was, indeed, only natural considering how much their comfort depended on the result. The equipment as now perfected, is extremely simple; so much so, indeed, that it seems wonderful it was not sooner adopted. The old framed knapsack is entirely discarded and a soft valise is substituted. The weights are distributed around the body, and are brought low down, with a view of gaining the great mechanical advantage of keeping the centre of gravity of the body as near as can be in the position in which it is in the unweighted person, and of allowing free action of the chest, and of the great muscles of the shoulders. The sacrum and the tops of the scapulæ, which are the two strongest parts of the body, bear the chief weights; and advantage is taken of the principle of balance. The equipment is most easily adjusted, and is put off or on in a moment. As the soldier must carry some weights he will still move at a disadvantage as compared with an unencumbered pedestrian, but this is far less than it was with the old system, and we may reasonably hope that all risk of injury to the heart and lungs from the pressure of faulty accoutrements has now been removed."

The Exhibition contained several suggestions, some of them merely fanciful and some highly valuable, for lightening the soldier's accoutrements and adding to his comfort and effectiveness. In the British section, among the private exhibitors of munitions of war, Mr. Scott Tucker showed a shortened bayonet for which he claims the following advantages: First, that it is lighter than the long bayonet; second, it is

not so liable to the inconvenience of "crossing;" and third, it can be carried in front like a dagger, and will be more handy to get at in action. The first advantage is only of value in the sense that "every little helps," for the entire weight of the long bayonet is only about one pound. It is obvious, however, that the short bayonet (which is only about 6 inches long), will prove of considerable advantage in manœuvring, and, in fact, I do not see why it could not always remain on the gun, now that breech-loaders are so much in vogue. SCOTT TUCKER concludes that "in the hands of good men," his 6-inch bayonet is "long enough for all practical purposes."

A very neat arrangement, calculated to lighten the soldier, and very materially add to his comfort, is shown in the Dutch section of the Exhibition. It is a neat and convenient field, or bivouac tent, and is formed of the cloaks of the two soldiers who are to sleep under it. The material of these coats is a firm water-proof linen cloth, dyed blue, and has the appearance of the blouses worn by the French *ouvrier*. The ridge of the tent is made by buttoning the edges of the cloaks together, the other edges being fastened to the ground by pegs, and the ridge is kept up at each end by a musket or sword. This simple contrivance, which provides a roof in a cold or rainy night for each individual soldier, has been awarded a bronze medal.

FIELD GUNS.

There is perhaps no branch of firearms in these days of change that, in Europe at least, remains so comparatively stationary as field ordnance. Not that there have been no changes of importance in this branch of late years, but the changes in heavy ordnance and breech-loading small arms have been so numerous and so rapid as to give quite a conservative character to field ordnance—the medium branch of firearms. Until the production of the GATLING battery in the United States the question of field ordnance attracted comparatively little attention. With these preliminary remarks I shall at once proceed to notice a few of the leading features which the Exhibition brings before us connected with this branch of firearms, and in the arrangement of these I shall avail myself of the digest of a military correspondent of one of the London journals, who considers the question from a European point of view.

As regards field guns it appears to me that the French were wise in hesitating, when first the necessity for rifled guns became apparent, to rush headlong into the enormous expense of a complete alteration of system. They rifled their old bronze NAPOLEON shell guns on the *système la Hitte*, and they still adhere to bronze guns and that plan of rifling. It is often argued that bronze is too soft for rifled guns, but I doubt whether, with studs of soft metal, an amount of endurance sufficient for ordinary purposes cannot be obtained. At all events these guns performed well enough in the Italian campaign for the authorities to

retain them; and the saving of expense has been incalculable. The French field gun is of the calibre of the old brass 4-pounder rifled; hence it is called the *canon de* 4 *rayé*. The projectiles employed are common shells and shrapnel of about 9 lbs. weight, and case-shot of about 16 lbs. The fuses, both time and percussion, are of metal. There is also a mountain gun of the same calibre, but much lighter, employing the same projectiles. The old bronze NAPOLEON guns are 25-pounders, now that they are rifled; their calibre is 12 centimetres. This gun is known as the *canon de* 12 *rayé*. For siege purposes they employ this and the *canon de* 24 and 16. All these are exhibited in the French war department building, or in the enclosure outside. The siege carriage is peculiar, having no traveling trunion holes, the gun resting on a curved portion of the brackets, where it is supported by bolts in traveling. Their field carriages are of wood, with block trails, and the mountain howitzer carriage is carried by two mules, the gun being on a third.

Austria, too, employs bronze guns in the field, and like the French, the same gun for horse artillery and field batteries, with six horses for the former and four for the latter. The calibre is rather less than that of the French gun, and the same nature of projectiles are employed; but in addition a certain number of incendiary shells or carcasses are carried with each battery. The Austrian gun of position is smaller in calibre than the French *canon de* 12. The system of rifling of these guns is very peculiar, the grooves being circular and eccentric and the projectile having a coating of tin

and zinc, with ribs corresponding to the grooves of the gun. The carriages are made of wood, and that for the *canon de* 8 has a bracket trail.

Austria and France represent the muzzle-loading system of field guns. The Prussians and Russians have adopted breech-loaders. KRUPP (the great steel manufacturer at Essen) exhibits three field guns, in addition to a muzzle-loader on the model of the French mountain gun. These are all breech-loaders; one is a 6-pounder on WAHRENDORFF'S system. The Prussians have a number (as many as a thousand) of these, which they are unable to convert into the later pattern, owing to the form of the breech being unfitted to receive the new breech-loading arrangement. Another is a breech-loader on KRAINER'S double wedge system, the present service pattern, in which the wedges having been pushed in together, a turn or two of a screw presses in a hind wedge so as to effectually close the breech. A loose steel plate on the face of the front wedge, containing a copper ring to check escape of gas, can be easily removed so as to allow of another taking its place, an operation not unfrequently required. Although this is the recognized service system, the Prussians have adopted KRUPP'S new breech-loading arrangement for their 4-pounders, the field gun of the service (Plates XXI, XXII). If so, they have done wisely, for it is simplicity itself, and there appears to be no want of strength. A single conical wedge, round in rear, is forced in so as to close the bore, or loosened so that it can be drawn out, by a screw working half in the gun and half in the wedge. The Russians have adopted this plan, and they prevent the

escape of gas by the use of the BROADWELL plate and ring, as shown in the 4-pounder exhibited by KRUPP. This BROADWELL ring is doubtless a complete success in field guns; and the Russians have not got a bad bargain if, as report says, they have paid very highly for it. It is made of elastic steel, its outer surface being spherical, and fitting into a spherical recess in the breech of the gun, and it has indentations on the back to receive fouling matter. A soft steel plate is fastened into the wedge by a screw, its face being flush with that of the wedge, and a circular rim projects a little from its face, in breadth corresponding to the back of the ring. When the gun is ready for firing, the back of the ring is pressed against by the face of the plate, but neither the plate nor the front of the wedge touch the gun. When the gun is fired the action is precisely that of the leather BRAMAH ring in a hydrostatic press, and the stronger the pressure the tighter the fit. The side of the ring is forced by the gas against the gun, its back against the projection on the plate, and no gas can by any possibility escape. The ring will last for some hundreds of rounds, and can be replaced in a couple of minutes if necessary. This identical gun is said by Mr. KRUPP to have been fired several hundreds of times with gradually increasing charges, up to $13\frac{3}{4}$ lbs. of powder, and 122 lbs. weight of shot, a sufficient proof of its strength.

The Prussians and Russians are, then, using KRUPP's breech-loading system with steel guns. They have also gone forward in the direction of wrought-iron carriages; but this does not appear from anything

exhibited at Paris. KRUPP shows a wrought-iron field carriage on THONET'S system, having a nave of gun metal, allowing of the removal of the spokes by the unscrewing of the outer and inner plates.

The remaining display of field guns of foreign nations is not very imposing. In the Swiss department, a private manufacturer exhibits some breech-loading guns of a very clumsy nature. In the Wurtemburg section BROADWELL shows a pattern service Swiss gun. It appears that the Swiss have had their bronze smooth-bores converted into rifled breech-loaders on BROADWELL'S system. They have, also, 100 new 4-pounders. A Saxon firm of steel workers show a small steel gun. The Egyptian government shows a bronze mountain howitzer, cast at Cairo, where also its carriage was made. It is rifled on the French system. Even Roumania will not be left out, and under the title of "Train d'Artillerie," shows a light field carriage with iron axletree, but no gun.

The only remaining European field gun of interest is that shown in the tent holding the warlike display of the Low Countries. Here both a siege gun and a field gun are shown, the construction of which is very peculiar. The siege gun is of cast-iron, the field gun of bronze, but both have a lining of gun metal, by which they have been reduced below the original calibre in order to strengthen them for rifling. It appears that since 1845, experiments in lining guns had been carried on at the Hague, but it was not till 1859 that M. MARITZ, a cannon founder, obtained perfect adhesion between the new and old metal. It is now claimed that these guns are strong enough for

all requirements; a field gun, of which a section is exhibited, being said to have fired 2,000 rounds. On this principle, the Dutch have lined and rifled all their old guns, using their old carriages, which are very heavy and clumsy. The rifling of these guns is of the very worst description, cutting very deep into the bore, and having very sharp angles. There are some arrangements in the field carriage here worth the inspection of an artilleryman, especially the method of carrying case shot on the axletree without a box, merely secured by an iron frame and leather cap, and capable of instant removal. The siege carriage has an iron bullet-proof mantlet.

The English field artillery not having undergone repeated changes like their heavy ordnance, a brief notice will be sufficient. The field gun of the British army is ARMSTRONG'S system, pure and simple. The method of building up the gun, the plan of closing the breech, and the projectiles, are ARMSTRONG'S. Lieut. REEVES' case shot has been introduced, but the segment still holds its ground; and though modifications have been made, and are still being made, in the fuses, the original principle of both the time and percussion fuses, used in the field battery and horse artillery, is ARMSTRONG'S. The introduction of this system is due to the fact that when the substitution of rifled guns for smooth-bores had become a necessity, ARMSTRONG came forward with a complete battery as it were—guns, projectiles and fuses; and that these, though since judged not to be equal to muzzle-loaders, were far better than anything else ready at the time. It was considered then that there was no

time for lengthy deliberation, and, accordingly, the plans were adopted in their entirety. The British have a good gun, though too delicate, and liable to occasional failure by the fracture of the vent-piece; its range, accuracy and rapidity of fire leave little to be desired. With regard to the two first qualities—range and accuracy—it is, however, much inferior to the Whitworth muzzle-loader, as was plainly showed during the trials of the two systems made by the Armstrong and Whitworth committee. This committee, which was assembled in 1866 to decide on the comparative merits of breech and muzzle-loaders, pronounced an opinion in favor of the latter; but the Commander-in-Chief, since that report, has pronounced his opinion that the balance of advantages hitherto proved in favor of muzzle-loaders is so small as by no means to warrant the expense of altering the entire system of field artillery.

Field carriages are tending slowly—very slowly—towards wrought-iron. The British government field carriages exhibited at Paris are wooden, and contrast very unfavorably with a wrought-iron carriage carrying the 12-pounder shunt gun exhibited by the Elswick firm, Sir William Armstrong & Co. The wheels of this latter carriage are peculiar, consisting of alternate spokes running from the outside and inside of the nave to the tire; they are easily removed, screwing into both nave and tire. Wheels of almost exactly the same construction may be seen in the models of a sling-cart and sling-wagon of wrought-iron, exhibited by the Spanish government from the museum of artillery at Madrid.

WHITWORTH'S 10-pounder is mounted on a wooden carriage with a complete equipment, and ready for action. He also exhibits a 2-pounder howitzer for mountain and boat service—one of the most unique and interesting specimens of light ordnance in the Exhibition. This piece has been very thoroughly tested at Versailles since the close of the Exhibition, with results, which for range and accuracy, give it the foremost place among light field guns. The FERRIS gun in our own section, beats it for range, but for accuracy and range combined, the WHITWORTH 2-pounder is unsurpassed. This little piece, when fired with the case shot illustrated in Plate XX, fig. 2, is a very destructive weapon. Firing at 200 yards range, at a target 28 feet long and 9 feet high, 147 hits, most of them through, were made with 10 rounds. The number of bullets in the case is 27. The charge of powder was $4\frac{1}{2}$ oz.; the weight of shot 2 lbs. 9 oz., and the angle of elevation 1 degree. The proportion of hits was over fifty per cent of the number of bullets fired. As compared with the shrapnel shell of the Royal Arsenal, illustrated in Plate XX, fig. 3, or with the segment shell of Sir WILLIAM ARMSTRONG, Mr. WHITWORTH'S case-shot had a decided advantage, and the ARMSTRONG and WHITWORTH committee "are of opinion that it is an invention of great value to Her Majesty's service." In a subsequent report on heavy guns, they say:

"The experiments, therefore, with the heavy guns entirely confirm the opinion given by the committee in their preliminary report with reference to field guns, that Mr. WHITWORTH'S case-shot is an invention of great value to Her Majesty's service."

With the following abbreviated account of the Gatling battery in the American section of the Exhibition—the greatest novelty in field-guns in Paris—I shall close this brief review of this branch of firearms and their projectiles.

There is not a single piece, except the barrels, which make up the component parts of the Gatling gun, that is like that of any other firearm; and the principle on which it is constructed is entirely different from that of all other arms. It may be termed an automatic machine gun, for it can be loaded and fired incessantly, and at the rate of 300 shots per minute; and, strange to say, it can only be loaded and fired when the barrels are in motion—that is to say, when the barrels, inner breech, and the locks are under revolution. All the cartridges are loaded and fired within the rear ends of the barrels, and there is no escape of gas at the breech; nor has the gun any recoil to destroy its accuracy. These several results are not attained by any other firearm. In all other arms known as "mitrailleuse" the barrels and locks do not revolve, and in order to fire, the cartridges have first to be loaded up into the chambers or plates which are detached from the barrels, and as a matter of necessity the cartridges to be used must fire across a joint. Moreover, there is an interval between each discharge, owing to the time it takes to change and reload such plates, as is the case in the Meudon gun or French "mitrailleuse." These intervals between each volley, allow an enemy to advance upon and capture the gun, or to cross its line of fire upon each discharge; while the Gatling gun loads

and fires all the time, giving an enemy no chance to advance or cross its line of fire.

Metallic cartridges as they come from the manufactory are supplied to the GATLING gun, as corn is fed to a mill, and the firing goes on as long as cartridges are supplied and as long as the gun is made to revolve. When the gun is once sighted at a given object, thousands of shots can be fired with great precision and without any change of its range; but its aim can be changed at the will of the operator to bear on any object. The first GATLING gun was made in the year 1862, and attracted great attention from all military men who witnessed its operation. In the year 1863 the inventor had a battery of six guns made at Cincinnati, but they were unfortunately destroyed by fire in the factory in which they were made. The inventor afterwards had twelve guns (of six barrels each) made at WELLS' type-foundry in Cincinnati, some of which were sold to the government and were used successfully near Richmond during the war. These were, however, very imperfect specimens as compared with the present gun, as it was not till 1865 that the inventor perfected his invention so as to load the cartridges directly into the rear ends of the barrels. Trials of the gun were made before the ordnance department at the Washington arsenal in 1865, with a gun of small calibre. These trials were so satisfactory as to induce General DYER, chief of ordnance, to request the inventor to construct guns on his system of one inch calibre, which would use metallic cartridges containing many small balls or one solid ball of half a pound in

weight; and at the same time General Dyer ordered Colonel S. V. Benét, the commandant of the Frankford arsenal at Philadelphia, to construct machinery to make the large metallic cartridges. In the meantime eight of the large size Gatling guns were manufactured at Cooper's firearms fabric in Frankford, Philadelphia, which were taken to the arsenal and submitted to repeated and prolonged trials under the supervision of Colonel Benét, and full reports of said trials were made by him to the War Department at Washington, giving a very satisfactory account. After the experiments had been concluded at the Frankford arsenal, three of the large guns were taken to the Washington arsenal and were there repeatedly fired in the presence of the board of officers for examination of breech-loading arms, of which General Hancock was president. Generals Grant, Dyer, Hagner, and Mr. Stanton, Secretary of War, and a great many other persons of distinction, witnessed the trials of the guns and were highly pleased with the result of the firing. General Dyer then ordered one of the guns to be sent to Fortress Monroe, to be used in competing trials with the 24-pounder flank-defence howitzer. The result was greatly in favor of the Gatling gun over the howitzer as a flank-defence weapon. After the above trials had been concluded at Fortress Monroe, the government, notwithstanding the war was over and all the arsenals full of arms, gave an order for 100 Gatling guns (50 of each size), which were made at Colt's armory in Hartford, and are now in the service. Two of the Gatling guns were exhibited in the Paris

Exhibition, and one of them was taken out of the building and a trial made at the target grounds at Versailles. The result led to the purchase of two guns for further trials, and these have since been fired repeatedly at Versailles targets placed from 1,000 to 2,400 metres from the guns, with the most satisfactory results. At one of these trials the Emperor and minister of war were present. The GATLING gun has also been tried at Vienna, at Berlin, and at St. Petersburgh. Also at the Hague, Holland, and before government officials of many other governments of Europe—all of which appear to have been satisfactory, and orders have been given for the guns, in greater or less numbers, by most of the leading powers.

A description of the mechanism of this gun, now so well known in America, is not necessary here. Its place in battle, which some military critics believe to be merely "the defence of a narrow passage or a breach," had better be left for future wars to decide. It is encouragement enough to the inventor and a valuable tribute to American genius to know that the weapon is being appreciated and purchased in respectable quantities by the leading military powers of Europe.

HEAVY GUNS.

It is not exaggerating to say that no single feature in the Exhibition of 1867 attracted so much attention as the display of heavy guns. To give even a partial and very cursory description of these wonderful evidences of human skill and energy that were scattered about the Champ de Mars would require the combined labors of the metallurgist, the engineer, and the artillerist. It would be necessary to speak of the proper treatment of ores, of the consequence of neglecting this important preliminary, and how such neglect at one time almost ruined the cannon trade of Sweden. To speak at all approaching to exactitude of the careful selection of ores and their skillful treatment at the French naval cannon foundry at Ruelle, would itself demand a lengthened treatise. This primary feature of gun manufacture in France receives the greatest and most scientific attention that the national resources can command.

Some account of this imperial establishment, of the royal gun factory at Woolwich in England, and of the no less important works of KRUPP at Essen in Prussia, would be necessary in any complete sketch of heavy ordnance at the present time, these three establishments being representative arsenals or manufactories of three distinct classes of heavy ordnance, viz: cast-iron, wrought-iron and steel. But this, however interesting, would be quite beyond the limits of this report. Further, no account of heavy ordnance can be complete without special reference to gun carriages and projectiles, and these it will

scarcely be possible to touch upon in these pages. As guns increase in size, the difficulties of the carriage question, especially for naval purposes, increase in a ratio resembling geometrical progression. This has led to the idea of making the ship or vessel the gun carriage which is to be handled so as to be the chief means of training the gun. I shall digress for a moment to refer more fully to this tendency of the great gun question. The neglect of those common sense views of ship-building as applied to iron-clads which prevail in the United States, namely, to expose little surface to the guns of an enemy, and effectually protect all that is exposed, has made some of the European powers, England especially, skeptical, or at least wavering, as to the value of iron armor at all. Hence a cry or demand has been got up for a class of vessels described by their advocates as follows:

"A boat named the 'Staunch,' built for the Admiralty upon the proposition and plans of Mr. RENDEL, of the firm of Sir WILLIAM ARMSTRONG & Co., has just been tried off the Tyne. This vessel, though wholly insignificant in appearance and cost, represents some very novel principles. She is only 79 feet long and 25 feet beam; her draft of water when loaded, 6 feet, and her displacement 150 tons. She has twin screws driven by two pairs of condensing engines of 25 horse power (nominal) combined, giving her a mean speed of 7½ knots. Such being her dimensions and power, it is hard to suppose that she can be in the least degree formidable. She carries, however, as heavy a rifled gun as any in the navy, and to all appearances carries it most efficiently. The gun, a 12½ ton 9-inch ARMSTRONG, is mounted in the fore part of the boat in a line with the keel, and fires through a bulwark or screen over the bow, which is cut down and plated something like that of a monitor. Thus placed, it is easily worked in a rolling sea, and its change of position by recoil

does not appreciably affect the trim of the vessel. At the same time, to provide for heavy weather, it is made capable of being lowered into the hold so as to relieve the little vessel of her deck load, and enable her to carry the weight as cargo. Machinery is also employed for the purpose of working the gun, by which means more than half the ordinary gun's crew can be dispensed with. It is in these mechanical arrangements that much of the interest of this vessel lies. The operation of lifting and lowering is performed by simple but powerful machinery. During the trials, the gun with its carriage and slide and the platform carrying them—weighing in all 22 tons—was raised and lowered in a rough sea, with the boat rolling 11 degrees each way, in from 6 to 8 minutes. When the gun is lowered, the gun-well is closed and the deck left perfectly clear, but in a few minutes the gun can be again brought ready for action. During the trials the 12½ ton gun was easily handled by six men, and fired with extra charges of 56¼ lbs. of powder, and 285 lb. shot. It must be observed that very little if any training is requisite with the gun of the 'Staunch.' The vessel is so small as to be a sort of floating gun carriage. Her twin screws enable her to turn rapidly in her own length. Her helmsman is placed just behind the gun. The gun, therefore, can be laid by rudder right and left with far more ease than any gun of similar weight otherwise mounted. At the trial, with the engines driving reverse way, the vessel made the full circle in her own length in 2¾ minutes. With both engines going full ahead she made by the helm a complete circle of 75 yards in diameter in 2¼ minutes. The 'Staunch' is wholly unarmored. Her strength and security lie in her great gun and her diminutiveness. Sixty such could be built at the price of one armor-clad frigate."

It is obvious that two erroneous ideas have influenced the calculations on which these floating gun carriages have been designed. First, the supposed impossibility of light draught gunboats or floating batteries carrying armor that could resist the ARMSTRONG 9-inch gun; and second, the prevailing notion that iron-clads must carry heavy guns only, and that these must fire solid shot or shell that will burst on

striking. It is not a difficult matter, as our own experience has proved, to build a monitor capable of carrying two 15-inch guns, and which will not draw over 9 feet of water. Such guns, firing shell with time fuzes, or case-shot, each internal sphere being a live shell, would soon dispose of the aforesaid flotilla of sixty cockle-shells. Barely able to float at the best, a trifling leak would sink such a craft as the "Staunch," and a very moderate sea would silence or render ineffective her single gun. These boats have been by their advocates compared to wasps, but the sting of the wasp is seldom deadly, and a single monitor, well provided with proper ammunition would speedily disperse Mr. RENDLE'S flotilla of sixty, just as a courageous schoolboy with a bundle of tough weeds would destroy a nest of wasps. The fire of the "Staunch," like the sting of the wasp, would be troublesome and annoying but both of these annoyances would be easily crushed. It is well to be able to give a hard knock, but give and take is the inexorable law of war, and we must prepare for both.

With this digression, I return to the hasty sketch of the main question, condensing, as in the case of field ordnance, the descriptions of a military correspondent.

Plunging at once into the *medias res*, all the French naval guns are breech-loaders, constructed on what is known as the marine system. A solid cylindrical plug of steel, whose outer surface is divided into six equal portions, alternately smooth, and cut into a male screw, is inserted into a corresponding cylindrical hollow in the breech of the gun, and *vice versa;*

but when once the plug has entered its full distance a sixth of a turn given to it by a small handle projecting in rear brings the screws together, and the gas cannot blow out the breech without destroying the entire screw. Escape of gas is checked, as in the Prussian and Russian guns, by the Broadwell ring screwing into the front of the breech-plug. A small projecting pin on the breech-end of the gun checks the handle of the plug when it has made its sixth of a turn, and prevents its going too far; while in making the turn the handle presses down a small pivoting projection, that rises up again when the handle is past, and prevents its accidental return. It may be interesting to give the particulars of the French heavy guns in detail, including the 42-centimetres gun. This gun is a smooth-bore, the others are rifled on the French system, exactly similar to what is called in England the "Woolwich" system, but with rather deeper grooves:

DETAILS OF FRENCH NAVAL ARTILLERY.

PARTICULARS.	16-centimetre gun.	19-centimetre gun.	24-centimetre gun.	27-centimetre gun.	42 c. m. gun, smooth-bore.
Total length	130.00 inches...	150.00 inches...	180.00 inches...	183.00 inches...	.....
Diameter at breech	25.00 inches...	30.40 inches...	38.60 inches...	44.60 inches...	51.20 inches.
Calibre	6.48 inches...	7.64 inches...	9.45 inches...	10.83 inches...	16.69 inches.
Weight of gun	4.90 tons	7.90 tons	13.80 tons	21.70 tons	37.50 tons.
Weight of solid steel shot	99.30 lbs.....	165.40 lbs.....	317.60 lbs.....	476.40 lbs.....	622.00 lbs.*
Charge of powder	16.50 lbs.....	27.60 lbs.....	52.90 lbs.....	66.20 lbs.....	110.00 lbs.
Weight of cast iron shell	68.50 lbs.....	114.70 lbs.....	220.60 lbs.....	317.60 lbs.....	463.00 lbs.
Charge for cast iron shell	11.00 lbs.....	17.70 lbs.....	35.30 lbs.....	52.90 lbs.....	73.00 lbs.
Rifling—No. of grooves	3.....	5.....	5.....	5.....	.....
Rifling—pitch	0 to 6°.....	0 to 6°.....	0 to 6°.....	0 to 6°.....	.....

*Spherical.

The French have adopted externally strengthened cast-iron, by re-inforce rings of steel, for the navy and the heaviest pieces in their fortresses, and have rifled their old bronze smooth-bores, as already stated, for siege guns and guns of position. It is evident that a bronze gun, originally designed to project a 24-pounder spherical shot, can scarcely be up to the strain caused by a 50-pounder elongated shot, when the gun has been weakened by rifling. The gun is of necessity too light in proportion to the weight of the projectile, and hence there must be a very violent and destructive recoil, even with the small charges of powder which it is able to withstand.

Of the French heavy guns which were sent in by private manufacturers, the Société Anonyme des Acieries d'Imphy St. Seurin, exhibits a BESSEMER steel *canon de* 8, the vent of which shows unmistakable signs of the severe test which has been applied, according to a notice appended, in the imperial foundry at Ruelle. One hundred and forty-five rounds are said to have been fired from the gun before its bursting, 90 of which were with charges of about 16 lbs. of powder, and 13 spherical shot of about 8 lbs. weight, a very severe test for such a small piece. But in French steel work, as applied to ordnance, the exhibit of Messrs. PETIER and GAUDET must be admitted to stand foremost. This firm supplies the government with the steel rings used to strengthen their cast-iron guns, and displays a series of such rings and trunnion pieces for guns of 16, 19, 24, 27 and 42 centimetres. An unwelded coil of steel is also shown, and a smooth-bored steel gun, of 16 tons weight and 9½-inch calibre,

the breech of which is, however, open, and not yet furnished with its closing apparatus. This gun has a tube of coiled steel, strengthened with steel rings shrunk on, is mounted on an iron carriage, and is ticketed as ordered by the Marine Impériale. To judge by a section of a broken steel gun of 19 centimetres, which lies close by, the steel of Messrs. PETIER and GAUDET, is of most excellent quality.

Passing to the second class or variety of great guns—the wrought-iron cannon manufactured at Woolwich, England, for the British government—it is hardly necessary to say that these guns were all made upon the ARMSTRONG, or coil system. The manufacture of these coils, especially when of large size, is one of the most interesting operations that can be witnessed in the forge. A long bar, heated to redness in a long low furnace, is drawn out so far as to attach one end to a mandril or cylinder in front of the furnace, and then the mandril revolves slowly and the great iron bar is wound round it, and encircles it in its glowing folds, as a huge snake coils round its victim. Removed from the mandril the bar is like a spiral spring, but heated to welding heat, it is soon hammered by the steam hammer into a solid cylinder, without separation or fault of any kind. Now, solid cylinder as it is, all the fibre of the metal is running round the circumference, and thus the very greatest strength it possesses is opposed to the strain which tries to rend the metal asunder in a line running parallel to the axis of the gun. To form the barrel of a gun, several short coils are welded

together, for if too long a coil were made, it would bend in the middle and be driven out of shape by the steam hammer. But all the metal in an ARMSTRONG gun is not coiled round the bore. There is another strain upon a gun different from that known as the tangential strain, tending to split the gun along its length—a strain which tends to blow the rear end of the piece away from the remainder—to blow out the breech, as artillerists say. And as the fibre of the metal should run in the same direction as the strain, in order to give the greatest strength, a great solid forging, made of piled up slabs of iron welded together, is bored out and placed on so as to support the back of the bore. In placing on this and all the other coils of the gun, the greatest care is taken to regulate the amount of tension to which they are subjected. The internal diameter of the outer coil is always less than the outside diameter of that it is to lie over, so that the outer piece can only be placed on when expanded by heat; gripping, as it cools, the portion within. The one-thousandth of an inch difference in diameter is roughly estimated as giving a pressure of 10 tons.

Plate XXIII is a representation of a 12½ ton 9-inch gun, manufactured upon this principle, and exhibited by Sir WILLIAM ARMSTRONG & Co. This gun is rifled on the Woolwich or French system, and is mounted on a wrought-iron naval carriage. The ARMSTRONG gun proper, consists of several coils shrunk on in separate layers with regulated tension, but the improvements introduced by Mr. FRASER, manager of the gun factory at Woolwich, have been adopted, as

stated and described above, in the manufacture of heavy guns. These improvements will be better understood by a description of Mr. FRASER'S method of constructing a 64-pounder.

Mr. FRASER'S 64-pounder consists of a coiled iron tube, of which the muzzle-part is a double thickness of coil, consisting of one bar coiled over another, the spiral in the second coil running the reverse way to that of the first, the two being then welded at the same time; and secondly, a triple coil, trunnion piece, and coil in front of trunnions, all welded together, and shrunk on together. There are thus only four parts to be separately forged, and two to be bored and turned, while there is only one operation of shrinking on. The saving of labor and expense by these improvements is evident to the most casual observer. Mr. FRASER says that in this triple coil, solid as it is, rests such longitudinal strength that he can dispense with the breech-piece—a costly item in the gun. He has now constructed a 10-inch gun, without breech-piece, having a steel barrel, strengthened just as the 64-pounder, with a triple coil over the breech. The royal gun factories show, on one side of the door of their building in the Exhibition grounds, such a triple coil unwelded for a 12-inch gun; it weighs no less than 18 tons in its present state. The exterior bar is 240 feet long, and the diameter of the circle made by it 56 inches. On the other side of the door is another such coil, welded to a trunnion piece; the forging is complete, and ready to be placed on a gun. In its finished state it weighs 15 tons.

Standing near the Armstrong 9-inch gun in the British private shed are the heavy guns of Armstrong's great rival, Whitworth. A 7-inch gun called a 150-pounder, a 5½-inch 70-pounder, and a 4¼-inch 32-pounder. These are entirely composed of tempered steel, and each consists of a central tube strengthened by external rings, not, however, shrunk on as in the Armstrong, French and Krupp's guns, but forced on by hydraulic pressure. The general form of the Whitworth bore is well known to be hexagonal, but perhaps the exact shape is not so commonly understood. The interior of the gun is first bored out cylindrically, and a small portion of this original cylindrical bore is left at the centre of each of the sides of the hexagon, when the bore has been brought to its correct form.

At these points in what is called a 7-inch gun, the bore is only $6\frac{3}{4}$ inches in diameter when the rifling is completed, and is even less where the circle is cut by the hexagonal sides; but from these latter points it again commences to increase, till at the circular arcs, which take the place of the angles of the hexagon, it is $7\frac{1}{25}$ inches in diameter. In fact, the bore is hexagonal, but the sides of the hexagon are undulating lines, and the angles give place to curves. The form and dimensions of the bore were arrived at by numerous experiments with a gun in the foulest state, and a number of projectiles varying by the thousandth of an inch in size, and they are so designed as to secure proper bearing surfaces for the hexagonal projectile, which is made smaller than the bore of the gun to ensure easy loading when foul, and yet to avoid

more windage than is necessary. Mr. WHITWORTH claims for his guns the important advantage of uniformity of system, simplicity of construction, and economy of production. It is especially in the matter of projectiles that economy cannot fail to be present in this system. for having been cast in sand moulds in the rifled form, they are speedily and easily planed to the exact form by self-acting machines. A 150-pounder solid shot can be cast, planed and made ready for use by one man in 28 minutes. These projectiles have undoubtedly the advantage of freedom from risk of injury by exposure or rough usage in traveling, for they are simple in form, and present no weak points.

These guns of Mr. WHITWORTH form, as it were, a connecting link between the second and last variety of heavy ordnance already mentioned. The WHITWORTH guns are strengthened by outer rings of homogeneous metal. In these rings they resemble the ARMSTRONG construction, and in the homogeneity of their metal they approach to KRUPP's cast-steel guns. These latter, but for their breech-loading arrangements (and they are almost all breech-loaders), would be as completely homogeneous as any cast-iron cannon, the 1,000-pounder alone excepted.

This gun is a rifled breech-loader, intended for the armament of coast defences against iron-clad ships. It consists of an inner tube, strengthened by rings shrunk on in a three-fold layer over the breech, and a double layer over the muzzle. The inner tube weighs, in its present condition, no less than 20 tons, and has been reduced to that from an ingot originally

40 tons in weight, by the removal of the deadhead, turning and boring. [The ton in this description of this gun is the English ton, of 2,240 lbs.] The outer rings are of soft steel, and are not tempered. They are made in the same manner as KRUPP'S weldless railway tires, which have attained such world-wide celebrity. A large ingot of crucible cast-steel is forged out into a flat rectangular piece, corresponding with the required weight, and split down the centre for a certain distance. The slot is then enlarged and opened out into a circular form by inserting and driving through wedges and cylindrical punches till the forging assumes the shape of a ring, only rather less in internal diameter than is required, so that it may afterwards be bored out. In the whole ring there is no joint or weld liable to prove a weak point; the metal becomes condensed in the process of forging, and the fibres run in the best direction. This immense gun (50 tons in weight) was in process of manufacture day and night for 16 months without interruption; and the railways possessed no wagons strong enough to remove it to Paris, the manufacturer had to construct its own wagon, which is wholly of steel and iron, and weighs no less than 24 tons. The steel carriage on which the gun rests in the Exhibition weighs 15 tons, and the 25-ton turn-table on which it should work could not be sent to the Exhibition for want of space. Taken as a specimen of steel forging, nothing could possibly be more perfect than this monster cannon. From beginning to end of the bore there is not a fault to be seen, and one is astonished at the marvelous organization of labor

that must have been required to cast so perfect an ingot of such immense size, when it is remembered that the units of melted steel, from which the great mass is formed, are not more than at the outside 60 lbs. each. For such a cast as this several hundreds of men are employed, and the most perfect precision must be observed in emptying the crucibles of molten steel at the exact moment into the troughs destined to convey the metal to the reservoir and thence to the mould, for were the stream to cease its continuous flow, the cast would be spoilt. And then, when long afterwards, the huge 40-ton cylinder, which has been kept at the heat known as cherry red, is brought under the steam hammer to be forged, who can fail to wonder at the perfection of the machinery which enables one man, by a movement of his arm, to regulate the mass of 50 tons, which falls from a height of 10 feet, with blows that, though they seem irresistible, scarcely perceptibly affect the forging? As a triumph of the metal-worker's art, combining both selection of material, casting and forging, this gun is almost unrivaled; and it excites little surprise that the price put upon it should be nearly $100,000, or with the carriage and turn-table complete, $130,000.

This monster gun was not fired before it was sent to Paris, and therefore its success as a piece of artillery is still problematical. The prevailing opinion is that the breech-loading arrangement has dangerously weakened the gun. Be this as it may, the 9-inch and other cast-steel guns of Mr. KRUPP on exhibition are well worthy of more attention than I can now devote to them.

A 9-inch gun which he exhibits is the model of some that the Austrians have ordered from him. It is, like all his ordnance, of crucible steel, and, with the exception of the separate trunnion-ring, is forged from one massive ingot under the 50-ton steam hammer. The breech-loading apparatus is peculiar, and consists of a single wedge, the front face of which is flat while the rear is circular. The wedge is made to advance or retire chiefly by means of a screw working half in the upper portion of the gun and half in the wedge, so that its rotation causes the wedge to move along it; but this screw alone will not give sufficient force to jam the wedge in so tightly as effectually to prevent the escape of gas; and therefore when the main work has been done, the final pressure is given by another screw whose end works in a wedge while its shoulder is held so that the screw itself cannot advance, by a simple catch sliding in the gun. This screw, which is left-handed, being turned, cannot advance itself, because of the catch, and consequently the wedge which it carries must move, like a nut upon a screw with fixed ends. As before stated, the surface of the wedge next the bore is perfectly flat, and escape of gas is checked by a copper cap.

The Austrians have tried this system at Pola in some 8-inch guns, and have ordered several 9-inch guns thus constructed. The Prussians have ordered some 6, 7 and 8-inch guns, and the Russians have adopted the system definitely for large ordnance. The gun exhibited is said to have fired 120 rounds with 330 lbs. shot and 45 lbs. of powder.

KRUPP'S steel guns present features of remarkable interest. Independently of the wonderful nature of his management of that most difficult of metals, and his admirable breech-loading arrangement, it is a fact that some of the greatest European powers have been and are his customers. Prussia is arming largely with his heavy guns. Russia has bought from him some hundreds of 8-inch guns, which are sent to St. Petersburgh in the solid block, and there turned, bored, rifled and fitted with their breech-closing arrangements; she has also had from him some 6-inch guns. And though Russia is now resolved no longer to trust to foreign manufacturers, but to cast and forge all her steel guns at the Aboukoff works, within 4 miles of St. Petersburgh, or at one or other of two additional factories, still it is the excellence of KRUPP'S steel which has determined her choice of that metal, and it is KRUPP'S system of breech-loading that she has chosen. Austria, too, as we have seen, is a customer for heavy guns. In fact, for one government or another, KRUPP'S establishment has turned out, or has on order for delivery, upwards of 6,000 guns.

KRUPP is the chief exponent of steel guns at the Exhibition; but BERGER, also a Prussian, exhibits an 8-inch gun on the Prussian double-wedged system, and two smaller pieces, close to KRUPP'S great show; and the Russian government shows a large steel gun, not yet fitted with any breech-closing apparatus, from the Aboukoff works, a specimen of their proposed manufacture. Austria shows no heavy guns; and the only other European power which exhibits

any large ordnance is Sweden. To these guns, which resemble our own in material, manufacture and appearance more than any other on the Champ de Mars, I might, and perhaps ought, to have given more attention. It is, however, as specimens of metallurgy more than as ordnance that they attracted attention and received a silver medal. Two large cast-iron guns came from the foundry at Tinspong, near Norköping, so well known for its beautiful iron, of which it turns out some 15,000,000 lbs. annually, about 2,500,000 being employed for cast-iron ordnance, and 1,500,000 sold to foreigners for the same purpose. Of these two guns, one is rifled on a system apparently very similar to the WOOLWICH system, the projectiles having zinc buttons; the other is a smooth-bore, and both are beautifully finished.

CONCLUSION.

With this condensed account of the heavy ordnance exhibited last year at Paris, I shall close this report, and in doing so, I desire to state that the several topics introduced have been merely touched upon; that it was not my intention to attempt in a brief report of this nature a full and detailed account of any branch of the materials of war exhibited in Paris. All that I intended to do was to group together the several points which, in my opinion, would be most serviceable to the State of New York, and most interesting to its citizens. In doing so,

whenever I found a description couched in language that accorded with my own view, and which set the subject treated upon in a proper light, I have not hesitated to use it, and if in every case a special acknowledgment of the source has not been made, I trust this general acknowledgment will be accepted.

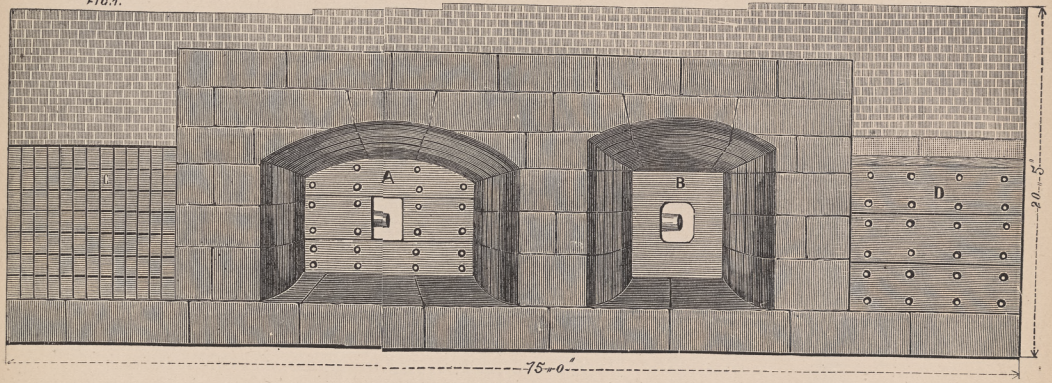
I cannot close this report without adverting to the large percentage of the skilled labor of Europe which is now being devoted continually to the preparation of implements of war. I do not so much allude to the—how shall I designate them—armies of intelligent mechanics and others employed in the government arsenals and dockyards of England, France and other European countries, as to the hundreds of private establishments—some of them of immense magnitude—which are scattered all over Europe. The mere manufacture of the plant of these ship-building, iron plate, cannon, small arms, and cartridge factories or establishments, represents an industry, the magnitude of which few can conceive. Some idea of the extent of these private establishments may be formed, when we consider that KRUPP'S works alone cover 450 acres; that there are 8,000 workmen employed at the works, besides 2,000 more at the coal-pits and iron mines connected with them. A statistical account of the ships of war built, and the number of cannon and small arms produced annually in Europe in these times of peace could not fail to be instructive and useful. There can be little doubt that the military European powers are now spending annually one thousand millions of dollars on war

materials and the maintenance of their armies and navies. To consider the causes and the necessity for this expenditure, or the lesson to be drawn from it, does not come within the scope of this report. Feeling that I have fulfilled a duty to my country in adverting to these wholesale military preparations, I respectfully commend the subject to the attention of the Governor and State of New York, and the military and naval authorities of the United States.

ILLUSTRATIONS.

PLATE I.

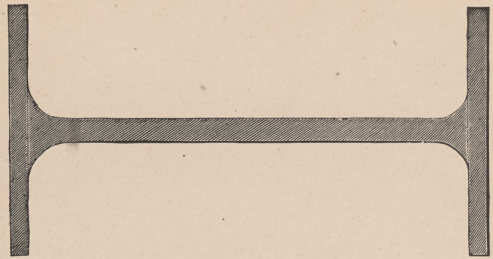
FIG. 1.



EXPERIMENTAL CASEMATE.

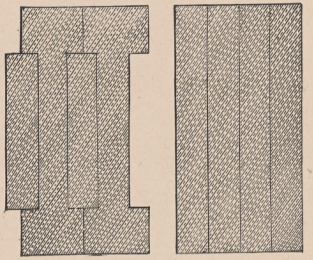
PLATE II.

Fig. 1.



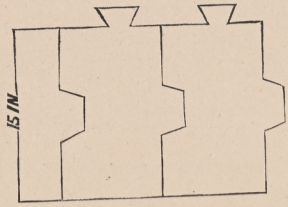
WROUGHT IRON GIRDER BEAM FOR CHALMERS' SHIELD.

Fig. 2.



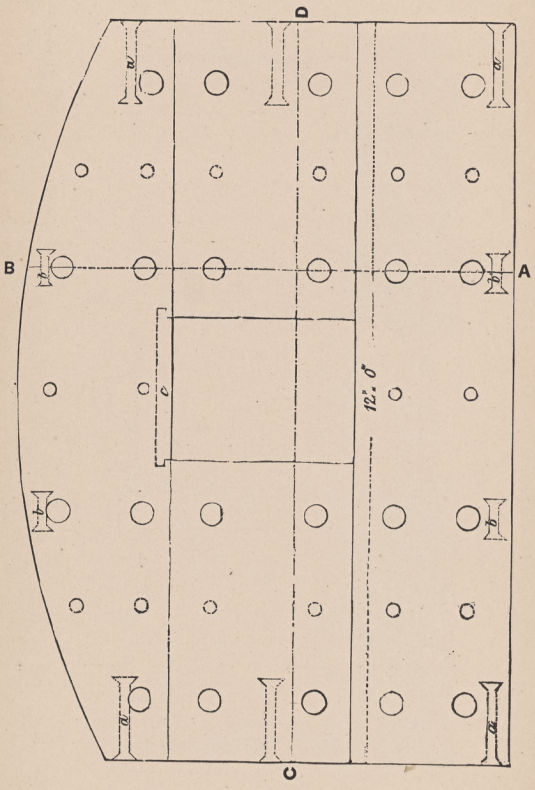
MATCH BARS. PLAIN BARS.

Fig. 3.



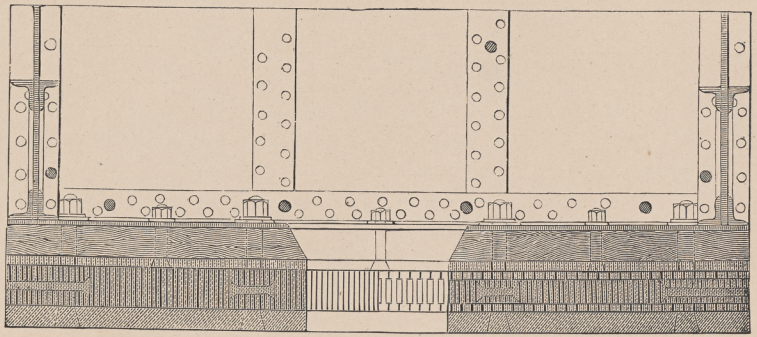
CRONSTADT PLATES.

PLATE III.



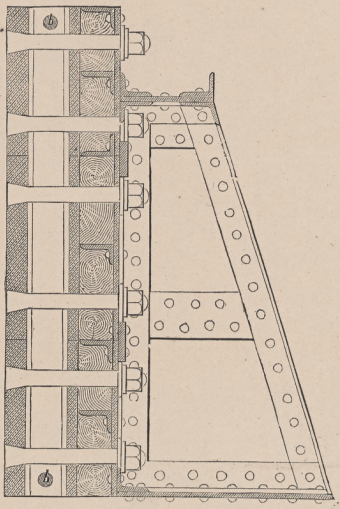
FRONT ELEVATION, CHALMERS' SHIELD.

PLATE IV.



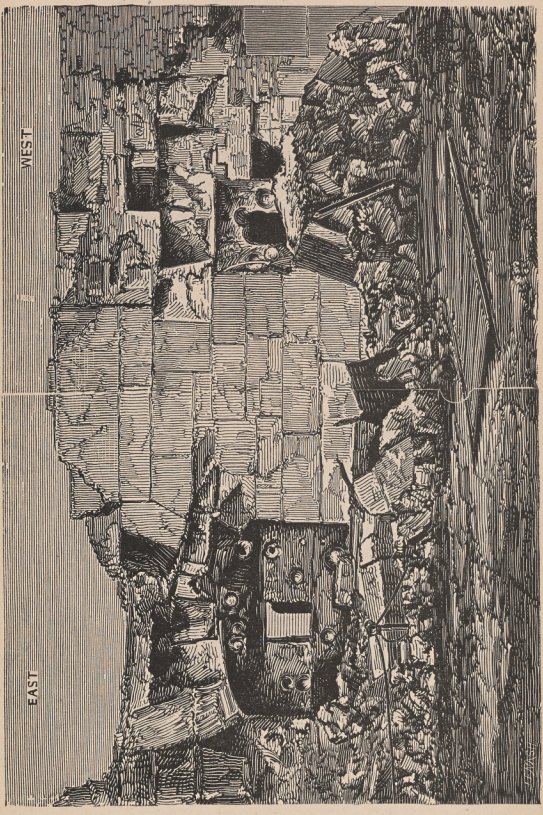
SECTIONAL PLAN ON C. D., CHALMERS' SHIELD.

PLATE V.



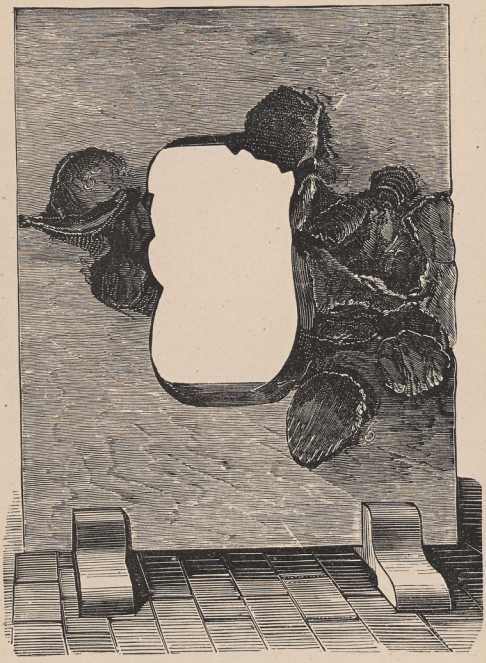
SECTION ON A. B., CHALMERS' SHIELD.

PLATE VI.

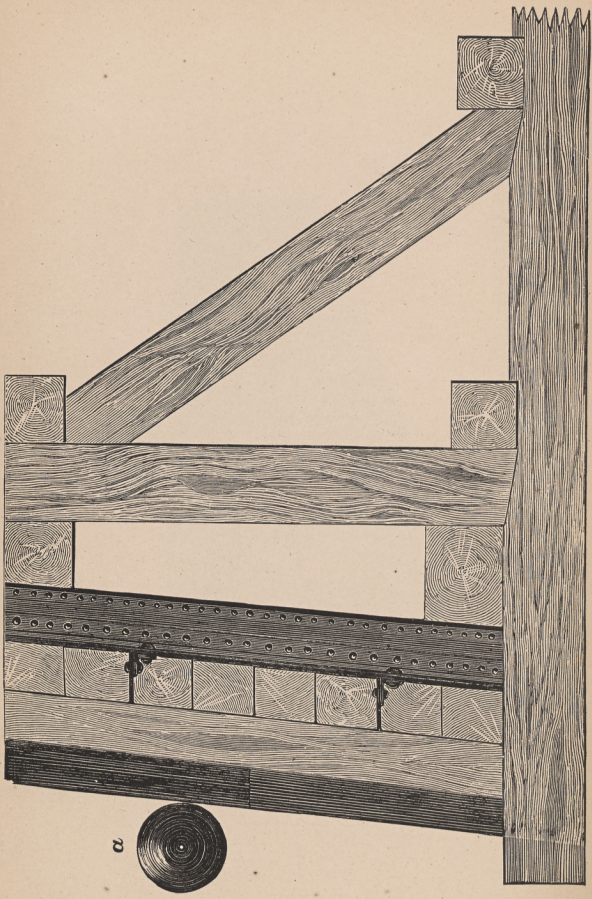


PHOTOGRAPH OF GRANITE CASEMATE.

PLATE VII.

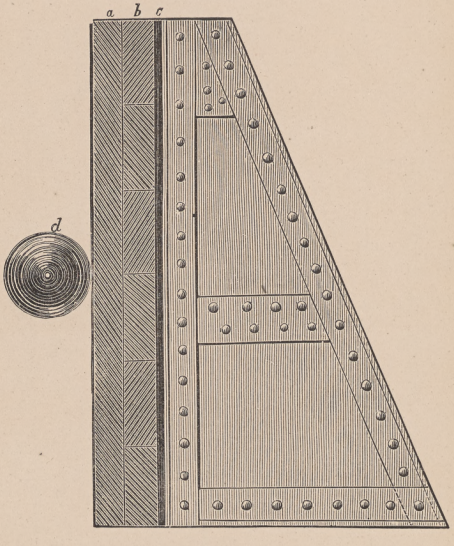


THICK PLATE SHIELD.



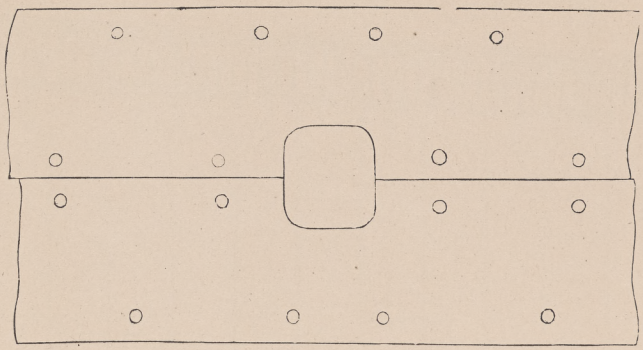
SECTION OF TARGET FIRED AT BY 15 IN. RODMAN. (U. S.)

PLATE IX.



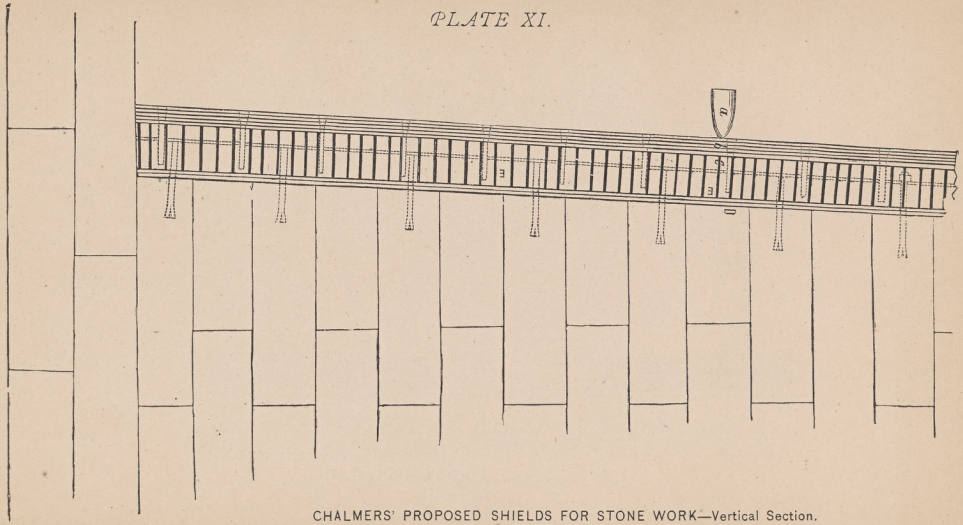
GIBRALTER SHIELD.

PLATE X.



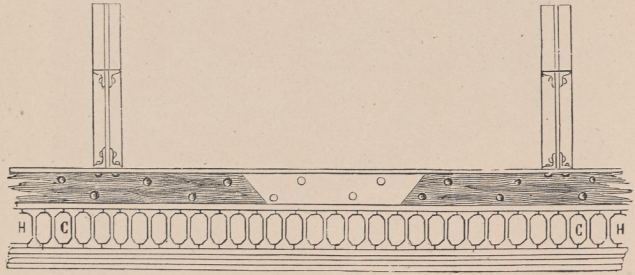
CHALMERS' SHIELD.—ELEVATION.

PLATE XI.



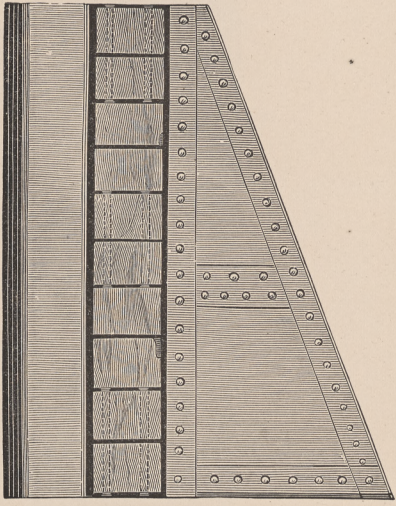
CHALMERS' PROPOSED SHIELDS FOR STONE WORK—Vertical Section.

PLATE XII.



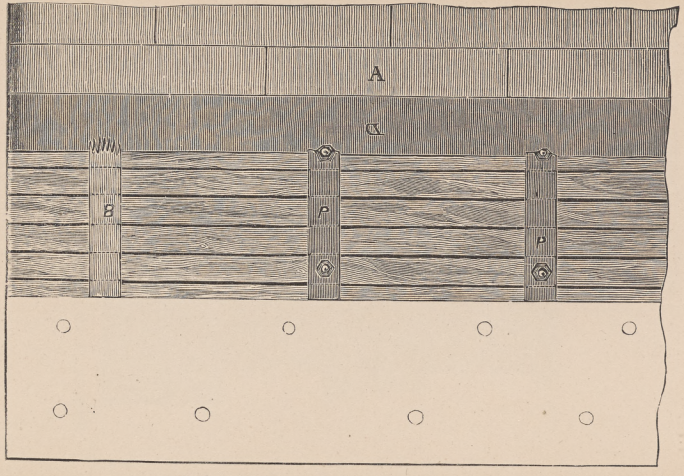
CHALMERS' SHIELD.—SECTIONAL PLAN.

PLATE XIII.



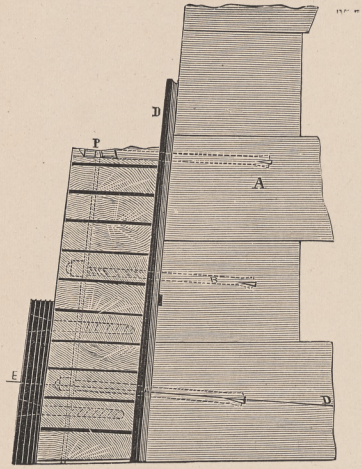
ARMOR FOR IRON FORTS.—VERTICAL SECTION.

PLATE XIV.



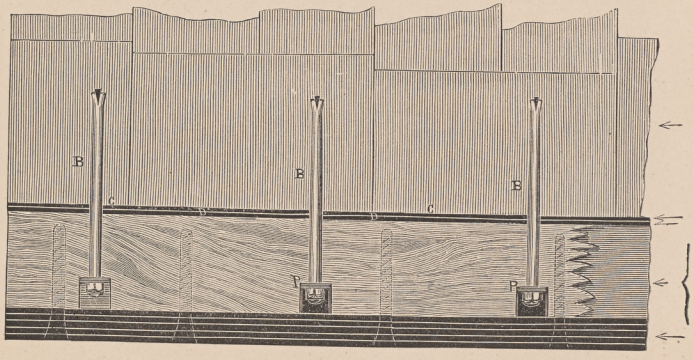
CHALMERS' PROPOSED SHIELD FOR FORTS.

PLATE XV.



CHALMERS' PROPOSED SHIELD.—VERTICAL SECTION.

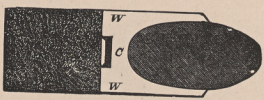
PLATE XVI.



CHALMERS' PROPOSED SHIELD.—SECTIONAL PLAN.

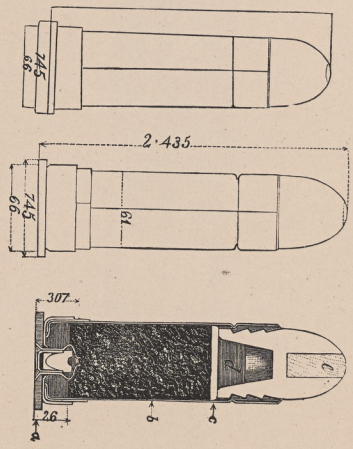
PLATE XVII.

Fig. 1.



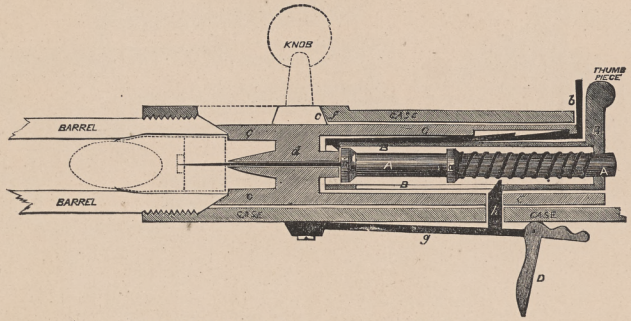
NEEDLE GUN CARTRIDGE.

Fig. 2.



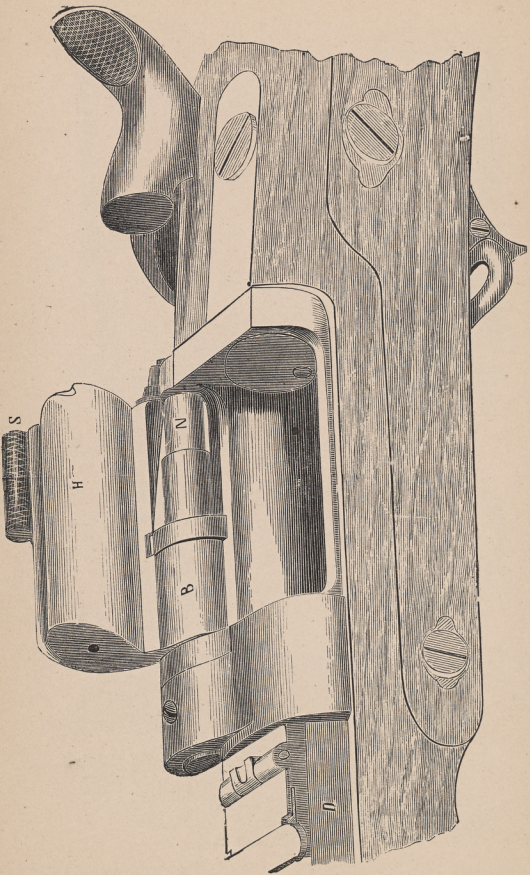
BOXER CARTRIDGE FOR SNIDER BREECH-LOADER. ENGLISH.

PLATE XVIII.



ZUND NADEL GEWEHR. (PRUSSIAN NEEDLE GUN.)

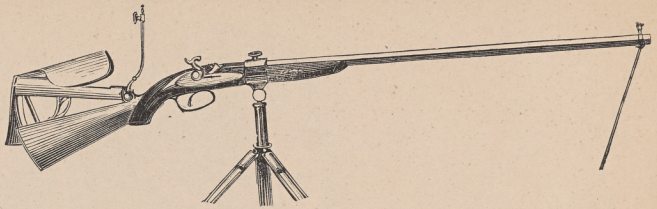
PLATE XIX.



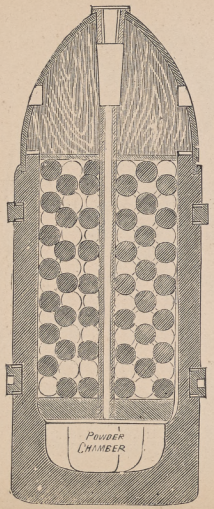
SNIDER RIFLE. BREECH-LOADING.

PLATE XX

Fig. 1.

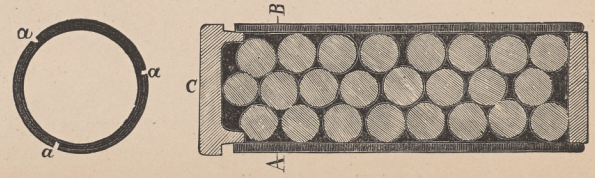


JONES' GUN, MOVABLE STOCK.



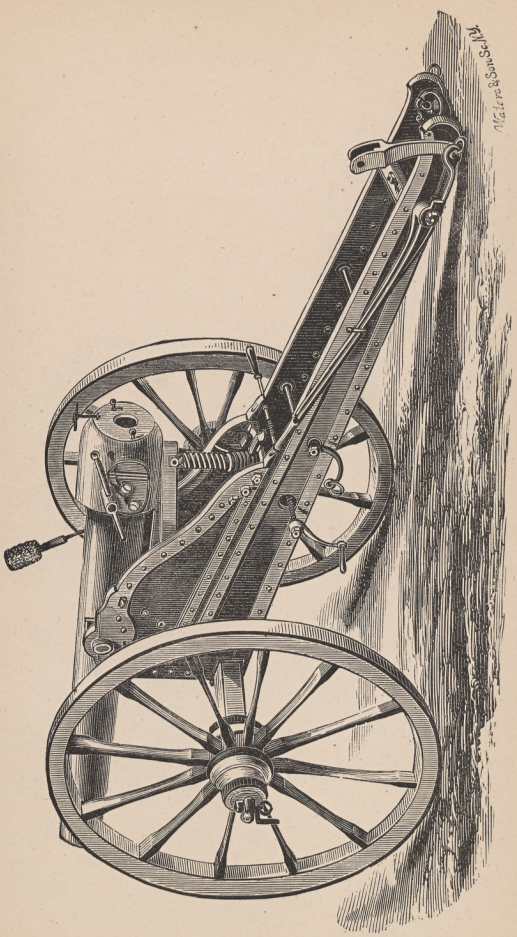
SHRAPNEL SHELL. Royal Arsenal, England.

Fig. 2.



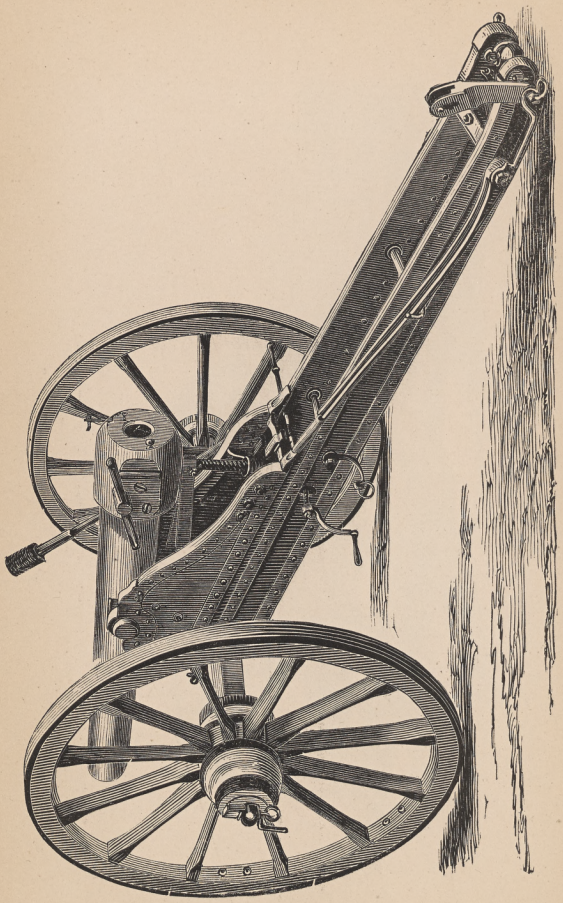
WHITWORTH'S CASE SHOT.

PLATE XXI.



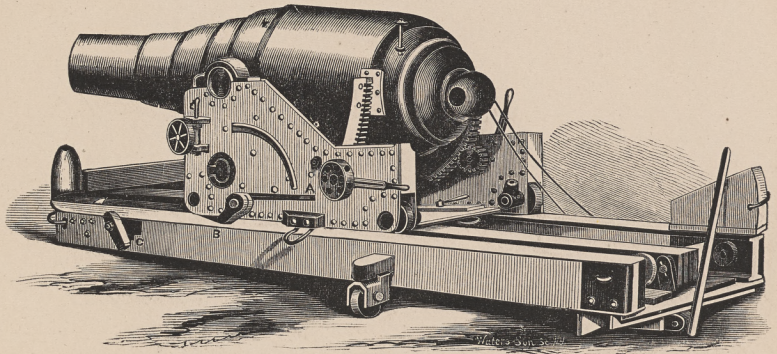
PRUSSIAN BREECH-LOADING FIELD GUN.

PLATE XXII.



PRUSSIAN BREECH-LOADING FIELD GUN.

PLATE XXIII.



ARMSTRONG RIFLED MUZZLE-LOADER, 9 IN. GUN, ON NAVAL WROUGHT IRON CARRIAGE.

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Because it has been said
"Ever'thing comes t' him who waits
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